

DOOM

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CUSTOM PC

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NVIDIA'S LATEST GPU MAKES
MINCEMEAT OF ITS PREDECESSORS

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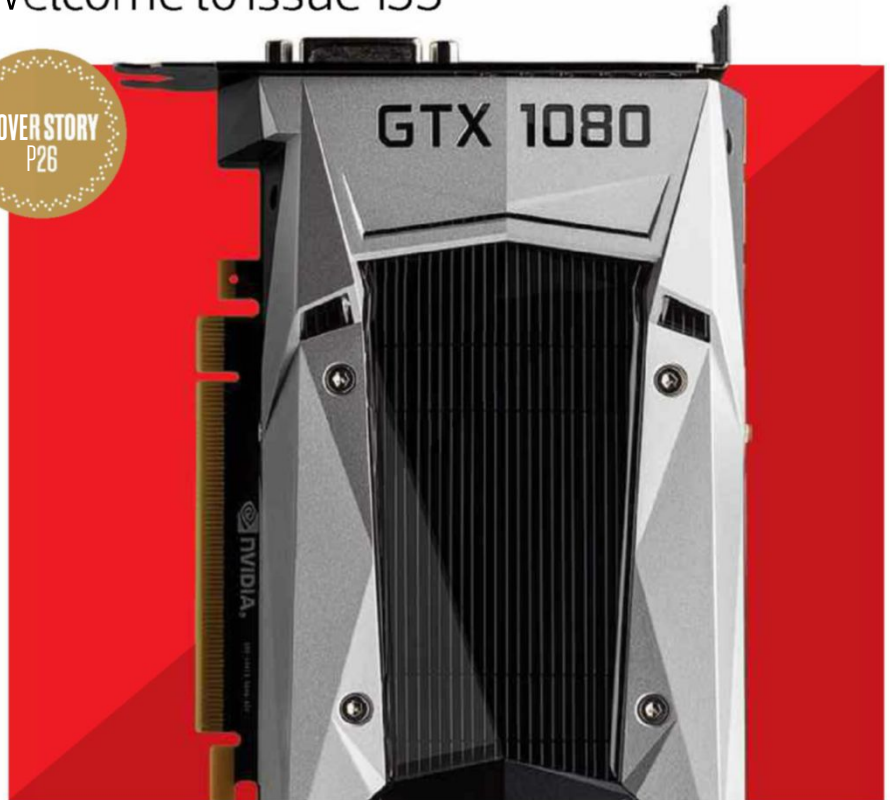
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26 Nvidia GeForce GTX 1080

Nvidia has finally unleashed its new Pascal GPU architecture, promising to beat the Titan X's frame rates into a pixellated pulp, and without eating a banquet of watts from your mains supply. The new card not only sees Nvidia using 16nm transistors for the first time, but it's also Nvidia's debut with GDDR5X memory.

What's more, Nvidia has taken a gamble on the popularity of its reference designs, marketing the new reference PCB and cooler as premium goods under the 'Founders Edition' banner.

Can a single graphics card really be worth £619 inc VAT? Can it properly handle 4K gaming? Can you overclock it? Can it play Crysis? All these questions and more are answered in our full review.



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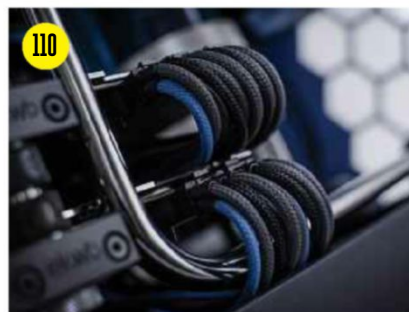
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BEN HARDWIDGE / FROM THE EDITOR

COME BACK, AMD

The silly prices of Intel and Nvidia's latest hardware shows that the PC industry desperately needs more competition, argues Ben Hardwidge

How much do you reckon the graphics card on our front cover costs? Go on, have a guess. You know it isn't going to be cheap, but you also know there's no 'Titan' or 'Ti' branding in the name. I'm guessing you'd hazard an estimate at a price of just under £400. At least, that would have been my first guess. But nope, it costs over £600. Not only that, but it turns out that Nvidia expects you to pay a hefty premium for one if its own reference coolers too.

That isn't the silliest price tag in this issue though. This month appears to be a month when Nvidia and Intel think they can stick any price on their top-end hardware, and the silicon-hungry masses will just hand over their cash without question. I'm not going to ask you to guess the price of Intel's first 10-core desktop CPU, the Core i7-6950X, because I don't think any rational person would guess it was actually priced at £1,400 inc VAT.

People are already making all sorts of excuses for these prices. Cutting-edge silicon has always cost a premium, they say, but it's been a very long time since it's demanded this sort of premium. The Core i7-6950X costs more than £500 more than the 8-core i7-6900K, and it's not as if that chip has a reasonable price either. But where else are you going to get a 10-core CPU or a fast single-GPU 4K gaming card? And herein lies the problem. Nowhere. Intel and Nvidia have no competition here, and with no competition, they can charge what they like.

Long-term CPC readers may remember when AMD's AMD64-based Athlon 64 and FX chips were stamping Intel's NetBurst chips into the mud, or when a new AMD GPU would nearly always be quicker than the Nvidia GPU that came before it. But those competitive days have passed. AMD has been stuck

with its hot, power-hungry and comparatively slow CPU architectures, and its similarly power-inefficient Graphics Core Next GPU architecture, for so long that Intel and Nvidia haven't needed to worry for years.

In fact, I started editing this magazine 4.5 years ago, and Graphics Core Next GPUs were already doing the rounds before I took over. Back then, it was great, and definitely an improvement over Nvidia's Fermi GPU architecture. But now AMD hasn't released a brand-new GPU architecture for nearly five years. It might have tweaked its GPU cores and added new features such as High Bandwidth Memory, but the underlying architecture hasn't really changed. Comparatively, Nvidia has released its Kepler, Maxwell and Pascal GPU architectures in the same time frame, each improving on its predecessor in terms of both performance and power efficiency.

Is AMD about to offer up some serious competition? I don't think so. The company has just unveiled the first GPU to use its new Polaris architecture (see p14), and it looks like a good chip for the money, but it isn't designed to take on the GTX 1080. If it can beat Nvidia's equivalent GPU in its price bracket then it could be a winner, but it looks as though AMD isn't trying to beat Nvidia and Intel's flagship hardware any more.

AMD would argue that high-volume products in the sub-£200 price sector are more important than flagship products, and that's true to an extent, but the prices of the latest top-end Nvidia and Intel hardware has really demonstrated that we really need some serious competition at the high end as well as in the mid-range. I sincerely hope AMD can return with a bang and restore some balance. **CPC**

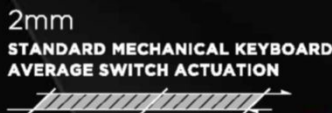
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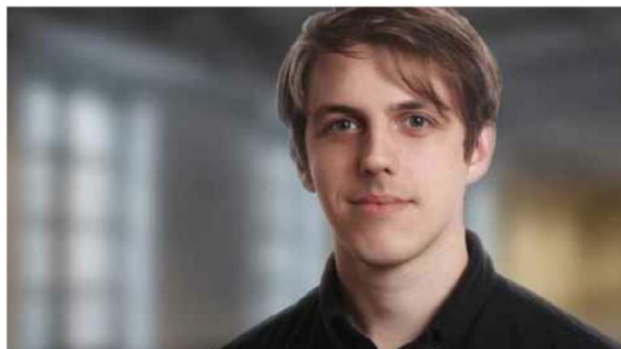


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RICHARD SWINBURNE / VIEW FROM TAIWAN

Computex 2016

SPECIAL

Richard Swinburne rounds up the best new tech hardware and gossip on show at the Computex trade show in Taiwan

MSI shows off Kaby Lake

MSI hid a Kaby Lake board around the back of its booth. Its 'Z2T0' (aka 'Z270') Anniversary Edition board (it's MSI's 30th anniversary) was shown with a launch date of November 2016. The Z2T0 Anniversary sports the same LGA1151 socket as existing Skylake boards – socket inter-compatibility is expected for upcoming Kaby Lake CPUs. Otherwise, the board sported many of the same features as MSI's Skylake boards – I really struggled to spot any differences!

Asus ROG Avalon

Asus' ROG Avalon is a modular PC chassis concept that reinvents the motherboard and removes all the cabling you would find inside your typical PC. All the connectors are flipped underneath the board, with adaptors facing downwards, leaving



EXCLUSIVE NEWS FROM THE SHOW

- MSI and Asus confirmed they're working on their super-high-end GeForce GTX 1080 Lightning and Matrix cards, although no launch dates are set yet.
- Intel stated that its Kaby Lake CPUs should be out in November 2016 at its press event, but partners at the show told me that Kaby Lake desktop parts are 'really Q117' (the first three months of 2017), so expect a limited release this year with most chip SKUs falling into 2017.
- Lian Li will have its own water-cooling kits soon, designed mainly around the company's mini-ITX cases. Not only that, but Lian Li is developing the design itself, rather than working with an established name, such as EKWB or Bitspower.



with a huge array of controller choices from Silicon Motion (SM2260G), Phison, Realtek (RTS5760) and even Seagate (SandForce SF3600). Several of these companies told us to be on the lookout for launches in the second half of 2016, and I'm looking forward to finally seeing competition for the dominant Samsung 950 Pro.

only the CPU and memory sitting on the top. The Asus ROG team claims that Avalon makes for a PC that's easier to build, cooler to run and adds a never-before-seen level of modularity, where even the rear I/O elements can be swapped out. As much as I'd love to lose ugly internal cabling, though, the Avalon concept shown at Computex buried all the kit deep in an aluminium box, so sadly all that neatness can't be seen.

M.2 SSDs

A whole new batch of M.2 SSDs were shown off this year, from Adata, Galax/KFA², Avexir and other manufacturers,

BitFenix Pillow

The BitFenix Pillow (yes, that's its real name) is certainly unique, and BitFenix gets our thumbs up for trying something new. This mini-ITX case's front, rear and roof panel are all curved,



and the latter enables you to see the graphics card. Meanwhile, two bars splay out on either side of the case, effectively suspending it in mid-air. Despite the unique design, it still supports full-length graphics cards, all-in-one liquid coolers and all the usual standard PC hardware.

Aerocool Dream Box

Admittedly, the Dream Box didn't launch at Computex but, credit where it's due, seeing Aerocool's various



Like MSI, In Win is celebrating its 30th anniversary and, never one to shy away from the wow factor, showed off its striking new D-Frame 2.0 and H-Frame 2.0 cases. Both chassis are upgraded from the previous designs, will be limited editions and have appropriately premium price tags. The D-Frame 2.0 has a tempered glass side panel and has been blinged up with a bright gold and matt black colour scheme, plus some oversized thumbscrews. A new feature with this second version is that you can now easily pop off a section of the frame to gain easier access to internal components.

Meanwhile, the H-Frame 2.0 has an orange and black

NEW IN WIN CASES



design, with two orange bars sitting parallel to the black aluminium 'blades' that make up its outer surface. It gets the same tempered glass treatment as the D-Frame 2.0, and the brightness of its LEDs can be adjusted via



buttons on the front I/O panel, which also includes three USB 3 ports and one USB Type-C connector. It looks smarter than the previous H-Frame, being a refined upgrade, but you'll have to really like orange.

demonstrations of ideas for this highly flexible case concept resulted in me imagining all sorts of possibilities.

The Aerocool Dream Box is basically a PC-focused Meccano kit that you connect and screw together, piece by piece, with almost complete freedom in terms of design.

Once I saw the towers, test benches and inverted designs you could build with the kit, along with a dash of water-cooling gear, my mind was really opened to the possibilities.

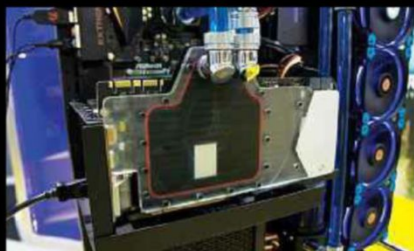
The Dream Box received a Best Choice award at Computex and deservedly so. **GPG**

ZOTAC WATER-COOLS GTX 1080 AND VR MINI PC

Zotac was showing off a water-cooled GTX 1080 card, which currently doesn't have a name. Zotac designed and manufactured the waterblock used, and while this concept design is understandably a little rough at the moment, it promises to be one of the few non-reference GTX 1080 designs with a proper waterblock, rather than an all-in-one liquid cooler, and a warranty.

Zotac also demonstrated its Magnus EN980, which the company claims is the 'smallest VR-capable mini-PC'. It features an Intel Core i5-6400 with an Nvidia GTX 980, along with two DDR3L

SODIMM slots, 802.11ac Wi-Fi, dual Gigabit LAN, one SSD slot and a USB 3.1 Type-C port. It's also fully water cooled. Using tiny bore-sized tubing, it cools every component, including the motherboard's VRMs, CPU and MXM graphics module, omitting only the motherboard's PCH chip. It's all cooled by a 120mm radiator in the roof. While the demo machine sat in an acrylic box, the actual case has a lovely design with curved, aluminium edges and a hexagonal grilled top. It seems a shame to hide all that water-cooling gear inside this box though.



Richard has worked in tech for over a decade, as a UK journalist, on Asus' ROG team and now as an industry analyst based in Taiwan @Bindibadgi



TRACY KING / SCEPTICAL ANALYSIS

ESPORTS ARE REAL SPORTS

Tracy King asks why eSports are still struggling to be taken seriously, arguing that they're just as 'real' as many Olympic sports

The idea of video games as competitive sports isn't new. Wherever there are games, people will offer bets or prizes. Computers resulted in more and different types of games, but the tendency towards competition remained. The earliest known competitive video gaming contest was Spacewar in 1972, with a prize of a year's Rolling Stone subscription. Eight years later, over 10,000 Space Invaders players took part in an Atari US competition.

Competitive gaming had arrived, but it wasn't until a large-scale Quake tournament in 1997 that eSports as a genre was born. The prize was a second-hand Ferrari, and the following year it was \$15,000 US cash. The same year, the first league was founded and eSports began to grow as a real business. In 2016, eSports Twitch streams attract millions of viewers, and in May, the World eSports Association (WESA) launched amid a flurry of PR and a few raised eyebrows, mainly because of concerns around potential advantages for founding teams.

Regulation is essential for eSports to become mainstream alongside other sports. Like traditional sports, match fixing has plagued tournaments, and performance-enhancing drugs aren't uncommon. Whether more regulation is the solution remains to be seen, and fears about the FIFA-for-eSports have merit considering, well, FIFA. But FIFA has something WESA may not ever have. Despite the big money and huge audiences, eSports struggles to be taken seriously by the public.

Part of the reason, I suspect, is that traditional sports such as football belong to traditional media, such as TV and newspapers, and new sports belong to the Internet. There's

also a cultural notion that video games aren't like other games that people play for money, and I think that notion is wrong.

Olympic sports may tend towards physical activities, but not exclusively. Olympic shooting is, according to the official Rio 2016 website, 'a true test of accuracy and demands intellectual and psychological skill rather than physical strength'. That could easily describe Starcraft.

Other 'real' games, such as darts or snooker, rely on similar combinations of visual accuracy and fine motor skills, just like Counter-Strike. Competitive chess requires almost no motor

skills; you could get someone to move your pieces for you and still win. Kasparov is world-famous, yet he's a games master whose skill is in his tactical thinking, not his body. Competitive gamers are employing tactical thinking *plus* physical fidelity, which brings gaming much closer to Olympic shooting.

Perhaps one issue is that video games and tech are constantly emerging, whereas chess is chess. Rule variants appear over time, but sports don't generally reinvent themselves every few years. Maybe your regular sports fan can't keep up, so won't invest the time and effort to be a fan. But the tide is changing, and not just because of the launch of WESA. This year, five US colleges offered eSports scholarships alongside traditional sport scholarships. These students practise up to six hours a day, and some have coaches. If acknowledgement by the National Collegiate Athletic Association follows, eSports will become mainstream. A League of Legends tournament could be as big a family event as the Superbowl or the World Cup. **GPC**

Competitive chess requires almost no motor skills

Gamer and science enthusiast Tracy King dissects the evidence and statistics behind popular media stories surrounding tech and gaming [@tkingdoll](#)

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Incoming

We take a look at the latest newly announced products



Roccat unveils new gaming keyboard

Roccat has gone back to basics with the design of its new Suora mechanical gaming keyboard, which aims to do away with superfluous frills and deliver the essentials. The new compact building features aluminium alloy casing and has a frameless structure, with no palm rest, thumb keys or media keys. That isn't to say there are no frills at all – you get a blue backlight with 11 brightness levels, which you can also set to a breathing effect. The Suora will also support Roccat's acclaimed Swarm software, is due for release in July 2016. UK pricing hasn't been announced yet, but Roccat recommends a retail price of €99 for the new keyboard.

Nvidia GeForce GTX 1070 coming soon

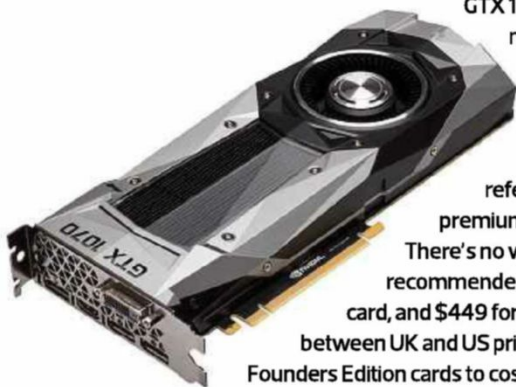
Hot on the heels of the GeForce GTX 1080 (see p26) comes the GTX 1070, promising a decent slice of Pascal silicon for a much cheaper price. The GTX 1080 is based on the same GP104 chip as the 1080, but looks as though it has one graphics processing cluster (GPC) disabled, as it only gives you access to 1,920 stream processors.

It also has a slightly lower GPU core clock speed of 1506MHz, compared to 1607MHz on the GTX 1080, with a 1683MHz boost clock. The other major difference is the memory, with the

GTX 1070 coming equipped with standard GDDR5 memory, running at 8GHz (effective), as opposed to the GDDR5X memory on the GTX 1080, though you do still get 8GB of it.

As with the GTX 1080, there will also be a Founders Edition of the GTX 1070 with a reference PCB and cooler, which will demand a premium over many cards with third party coolers.

There's no word on UK pricing yet, but Nvidia has stated recommended US pricing of \$379 for a third party GTX 1070 card, and \$449 for a Founders Edition. Given the difference between UK and US pricing for the GTX 1080, we expect GTX 1070 Founders Edition cards to cost just under £400 inc VAT.



AMD launches VR graphics card

In a bid to attract gamers wanting to build a VR-capable machine without spending too much cash, AMD has unveiled a new sub-\$200 US GPU designed to be capable of VR gaming. The new Radeon is the first GPU to be announced with the company's new Polaris architecture, marking a very different launch strategy to previous GPU architectures. Instead of announcing the flagship cards first, AMD is instead planning to release what it considers to be 'high volume' products in order 'to support continued market share growth for Radeon GPUs'.

The RX 480 still looks like a pretty decent GPU, though, particularly for the planned price. It will have 2,306 stream processors, support for HDR rendering, a 256-bit memory interface and it will include either 8GB or 4GB of memory, depending on the card. Interestingly, AMD also claims the GPU has a TDP of just 150W, marking a massive improvement in energy efficiency compared with the Radeon R9 390 and 390X cards. The Radeon RX 480 is set to launch at the end of June 2016 – we'll bring you a review as soon as we can get hold of a sample.



Corsair reveals ROG memory

Corsair has teamed up with Asus to launch a new kit of Dominator Platinum modules featuring Asus' Republic of Gamers (ROG) branding. The new XMP 2-certified 16GB (4 x 4GB) DDR4 RAM kit runs at 3200MHz with the standard XMP 2 profile, but can run at 3333MHz using a ROG XMP 2 memory profile on supporting Asus ROG boards. In order to match the colour and appearance of Asus' ROG boards, the memory modules also have a red aluminium top bar.





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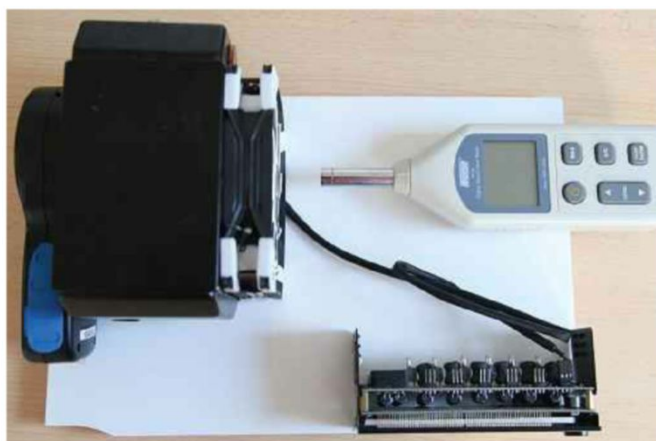
Follow your noise

Thank you for another excellent magazine. **Custom PC** continues to be the standout publication of choice. I had been waiting for a comprehensive case review for some time, and was delighted to see it was a feature last month. However, I was disappointed that acoustics were not part of the review. Everyone would agree that CPU and GPU cooling are the two most important elements, but decibels are increasingly an important consideration. In all of my previous builds, I've sought a balance between cooling and noise and I'm aware this is the case for many others as well. For future case reviews, could acoustics be a consideration, or maybe we could even have another case review in the near future looking at 'quiet' cases and cooling.

JON GREETHAM

Ben: I completely agree with you about the importance of noise – it's one of my primary considerations when purchasing a case and cooling gear too. Our problem with accurate noise testing for cases has always been accuracy – we have a noise-level meter, but there's always a lot of ambient noise at the Dennis labs in London, and it's hard to account for this noise when it's so variable.

We're working on getting accurate noise levels by testing at different locations, which is easier with smaller gear that doesn't require so much space. We've made a start in our quiet 120mm fan Labs on p54, where you'll find decibel levels for each fan at both 5V and 12V, as well as a decibel



Our test gear for 120mm fans now includes a noise-level meter

calculation based on what the human ear can perceive. Hopefully, we'll be able to use this system to get decent noise-level results for cases in the future too.



Give us more micro-ATX cases

Ben, not so long ago you wrote an editorial about how we don't really need such massive cases anymore, as we don't need optical drives, and now have high-capacity hard drives, SSDs and so on, which made lots of sense (even to an optical drive owner like me). So I was keen to read last issue's case group test, only to find that all the cases were full-sized ATX ones! At least your last group test had some micro-

ATX cases to read about.

That's not to say the test wasn't a good one – the usual **Custom PC** standard was maintained, but that was little consolation to a prospective micro-ATX case owner such as myself. In fact, I get the impression that we're getting overlooked in favour of mini-ITX cases in terms of column



inches. Is there any chance of a separate micro-ATX case group test in the near future?

RICK BILLSON

Ben: You're right that mini-ITX cases have been getting all the column inches recently, which is partly because we're seeing lots of new mini-ITX cases, but also because we've had some problems with our ATX and micro-ATX test gear over the past few months, and we didn't want to review any cases until we could be sure our results would be accurate. Once that was sorted, we decided to do an ATX case Labs first, and yes, there will very probably be an upcoming micro-ATX case Labs too.

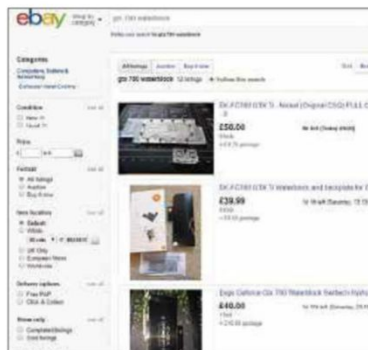


Selling old gear

Greetings from Northern Ireland. First off, thanks for the awesome mag. Having been an avid console gamer for over ten years, and wanting to get into PC gaming for several years, I finally bit the bullet and built my own gaming PC (a Devil's Canyon rig with a GTX 970). With the help of **Custom PC's** build guides, product reviews and supplier recommendations, this rig has made me a complete convert, with amazing performance and graphics at smooth frame rates, plus fast load times, a mechanical keyboard, high-dpi mouse control and a tonne of options not available on any other platform.

I've had this rig for around a year now, and with the incoming Nvidia Pascal and AMD Polaris based graphics cards on the horizon, I'm feeling the itch to upgrade my system in the near future with a custom water-cooling loop and a new graphics card. That's left me with a dilemma, though, which is what I should do with my old hardware after my rig has been

Decibels are increasingly an important consideration



There's a market for second hand water-cooling gear, if you look after it

upgraded. Do you have any tips about the best places to sell computer hardware, and how to value your old hardware and sell computer hardware? Also, is there a market for selling used PC water-cooling gear, considering my future need for a new GPU full-cover waterblock?

Having done some research, it seems that Gumtree can be mostly a waste of time, CES is only worth it if you trade for in-store credit, and it only trades in CPUs, GPUs, RAM and storage drives. Other options I know include eBay and forums. Considering the speed at which new computer hardware becomes available, selling my old gear is likely to benefit me greatly in the future whenever I want to upgrade.

Finally, please keep up Antony Leather's great modding and water-cooling guides. I've learned a great deal from them.

CAMPBELL POOTS

Ben: Thanks for your kind comments, Campbell, I'll make sure Antony knows you love his work. Selling your PC hardware can be a bit of a minefield, and it's often hard to gauge how much

money you'll get for your old hardware. One problem with selling old water-cooling gear is that the people who are very into custom water cooling are often the same people who want the very latest tech. That's a generalisation though – there's definitely a market for second hand water-cooling gear, particularly as waterblocks for last-gen GPUs are often quickly discontinued as soon as a new GPU comes out.

However, from my own experience, there's a risk that when you buy a second-hand waterblock, it might not have been looked after and cleaned properly. You may well get more bites if you flush it out properly first, and post some good photos to show its condition. Otherwise, your best bet with selling second-hand computer gear is to opt for a system where you can set the price and you're dealing with knowledgeable people, such as enthusiast forums.

WHEN'S THE NEXT MAG COMING OUT?

Issue 156 of Custom PC will be on sale on Thursday, 14 July, with subscribers receiving it a few days beforehand.



Twitter highlights

Follow us on Twitter at @CustomPCmag

RobyMorocutti For anyone bored, this is my new budget build after ten years with the old pc. #hardware #computerporn



@CustomPCMag

Ben: Neat, colourful and simple – I like it.

aazzgard hey guys have I missed something and not seen a

review of the Nvidia 1080 card in the last couple editions of the mag?

Ben: We couldn't run it in the last issue because of a non-disclosure agreement. Turn to p26 and you'll find plenty of Pascal goodness.

J_Bomb_3k On reaching p112 issue 154, I nearly spat out my drink: I'm

15	910208	100.2%	richardpaul	AT
16	979386	100.7%	mbrooke	AT
17	107290	105.0%	mbrooke	AT
18	952465	103.6%	du80786	AT
19	171554	103.6%	mark_groff	AT
20	172808	105%	mbrooke	AT

18 on the leaderboard! My ghost = flabbered

Ben: Good work!



tgriley1 Looks like you have a new reader.

Ben: Aw, get them started young!

aravella Is it wrong I get slightly aroused by sexy custom rigs?

#gamersunite #pcgamer

Ben: I'm not sure about getting aroused, but well-built, custom PCs are often things of beauty!

I'd only go to CEX as a last resort, as you won't end up with much money, and if you use eBay, I'd advise setting a healthy reserve to make sure you don't end up out of pocket. Also, set your price fairly, thinking about what you'd be happy to pay for your hardware. So many people seem to think they can sell last-gen hardware for not much less than new hardware, and they inevitably end up disappointed.

We've previously considered doing a 'for sale' section in the magazine, but it would be tough to regulate and we wouldn't want any of our readers to end up getting ripped off.



More surround speakers please

I totally endorse Stewart Ayers's comments regarding a 5.1 speaker Labs test. I'm using currently the excellent Logitech Z5500 set, which was recommended by Custom PC all those years ago. However, I'm now in the market for a new set. Any help would be great!

VICTOR WONG

Ben: Duly noted, I'll put it on the list. **GPC**

Send your feedback and correspondence to letters@custompcmag.org.uk

Reviews

Our in-depth analysis of the latest PC hardware

GEFORCE GTX

GEFORCE GTX

Reviewed this month

Intel Core i7-6950X p19 / Intel Core i7-6900K p19 / Asus X99-A II p24 /

Nvidia GeForce GTX 1080 Founders Edition p26 / In Win 303 p32 /

XSPC RayStorm Pro Ion AX240 WaterCooling Kit p34 / Corsair Lapdog p36 / Custom kit p38

INTEL LGA2011-V3 PROCESSORS

Intel Broadwell-E

Intel Core i7-6950X / **£1,400** inc VAT

Intel Core i7-6900K / **£895** inc VAT

SUPPLIER www.scan.co.uk

It seems a little strange coming across the Broadwell brand again after its anticlimactic fizzle when it launched last year. Following delay after delay, Broadwell launched so late that its successor, Skylake, came out just a couple of months later. The two main Broadwell desktop chips had lower clock speeds than their Devil's Canyon predecessors, and system builders complained to us about their comparably poor overclocking capabilities. In fact, we've never even managed to get our hands on a Broadwell desktop chip, until now. This time, it looks as though Broadwell's teething problems have been solved, and it's now back with a bang in its LGA2011-v3 'E' (Extreme) format.

The big news about Broadwell-E is that it sees the introduction of Intel's first 10-core desktop CPU, the Core i7-6950X. In addition, this launch also sees a new 8-core chip, the Core i7-6900K, and two new 6-core chips, the Core i7-6850K and i7-6800K. As with Haswell-E, the cheapest chip only offers 28 PCI-E 3 lanes, while all the other chips can supply 40 PCI-E 3 lanes to your graphics and SSD hardware.

Otherwise, the chips are very similar in terms of specifications. Each CPU has 32KB of L1 instruction cache and 32KB of L1 data cache per core, along with 256KB of L2 cache per core. There's then a pool of L3 cache shared between the cores – 15MB of it in the 6-core chips, 20MB in the 8-core CPU and 25MB in the 10-core i7-6950X. As with their LGA2011 predecessors, all the Broadwell-E CPUs also support Hyper-Threading, so the Core i7-6950X can handle a whopping count of 20 threads simultaneously.

What's new?

The fundamental Broadwell architecture hasn't changed since its launch last year; it's just now had time for Intel to perfect its manufacturing techniques. Broadwell-E sees the

Transistor fins are now thinner, taller and spaced more closely together



introduction of Intel's 14nm Tri-Gate 3D transistors to the LGA2011 socket for the first time, as opposed to the 22nm transistors in the preceding Haswell-E chips, enabling the company to get ten processing cores in a single die package.

Broadwell's 14nm transistors are based on the second generation of Tri-Gate, where the transistor fins are now thinner, taller and spaced more closely together, and Intel says it needs fewer fins too, reducing the area occupied by a transistor and thus also the die size. In fact, Intel claims that a 14nm SRAM cell size occupies almost half the area of the same cell with 22nm transistors. Smaller transistors also require less power to switch, and should output less heat too, reducing the power requirements and heat output of Broadwell chips.

The other new factor, of course, is the price. Intel has always charged a premium for its latest, top-end multi-core chips, but at £1,400 inc VAT, the Core i7-6950X brings this premium into a new level of silliness.

It's as if Intel is just experimenting to see how far it can push people who want the latest and greatest tech – it makes even the £895 Core i7-6900K seem modestly priced in comparison.



Thankfully, the prices reach a much more sensible level further down the line, with the entry level i7-6800K costing £360 from www.scan.co.uk

Turbo Boost 3

There isn't really much to discuss about the Broadwell-E architecture that hasn't already been covered when Intel first launched the original Broadwell CPUs last year, but one very interesting new feature for enthusiasts is the introduction of per-core overclocking, which also sees a new iteration of Intel's Turbo Boost technology.

Take a look at the graphs on p22, and you'll notice that the

Broadwell-E chips are significantly quicker than the Skylake-based Core i7-6700K in all but one test, our Gimp image editing test. That's because our image editing test is mainly single-threaded, so it responds much more strongly to clock speed than more cores. The same is also true for most games.

That situation causes a problem for Intel, as it's marketing its LGA2011 chips

heavily at gamers – they're the only CPUs that can give you 40 PCI-E 3 lanes for multiple graphics cards, after all. That's where Turbo Boost Max Technology 3 comes in. The new technology locates the highest-performing core in your CPU and overclocks it with the aim of evening the balance.

The idea is that overclocking just a single core, rather than all the cores at once, will mean you can get a higher clock frequency. After all, if only one core is overclocked, and all the other cores are running at stock speed, the heat output will be much lower – you can't overclock an 8-core chip as

high as a 6-core chip. At the moment, owners of Broadwell-E chips will be able to direct single-threaded applications and games to that one core using Intel's software, and Intel hopes Windows will eventually take over this role in the future to make it seamless.

Sadly, we haven't had the opportunity to try out the software yet, as it wasn't available when we were testing our samples, but we hope to give it a full work out next month. If it works then it looks like a great feature – it potentially means you can truly get the best of both worlds, with decent gaming and single-threaded performance and super fast multi-threaded performance.

Performance

Without access to Intel's Turbo Boost Max Technology 3 software, we weren't able to boost the single-threaded performance of our test CPUs as far as possible. As such, it's no surprise that both the Core i7-6950X and i7-6900K performed relatively poorly in our Gimp image editing test, with scores circling the 50,000 mark, which lag behind the 63,527 of Intel's far cheaper Core i7-6700K Skylake chip. Hopefully that's a situation that will change once Turbo Boost Max Technology 3 is up and running.



Otherwise, though, these new CPUs ripped through our benchmarks with glee. The most significant gains can be seen in our heavily multi-threaded Handbrake H.264 video encoding benchmark, where the 10-core chip really shows the advantage of its two extra cores. At stock speed, the Core i7-6950X's score of 520,109 in this test is simply phenomenal.

The 8-core Core i7-6900K also does well in this test, with its score of 449,460 showing a significant boost over the 397,506 of its Haswell-E predecessor. That's a result of an extra 200MHz clock speed (the 6900K is clocked at 3.2GHz, while the 5960X runs at 3GHz, and the former has a higher Turbo Boost clock too), as well as the architectural tweaks brought with the move to Broadwell. Our heavy multi-tasking test also saw some decent gains with the new chips, especially when compared with the scores from Skylake CPUs.

Where you'll really see the benefit of these CPUs with many cores, though, is in properly multi-threaded workstation software. To assess this performance, we

CORE i7-6950X / SPECIFICATIONS

Frequency 3GHz

Turbo frequency 4GHz

Core Broadwell-E

Manufacturing process 14nm

Number of cores 10 x physical, 10 x virtual

Cache L1: 10 x 32KB instruction cache, 10 x 32KB data cache; L2: 10 x 256KB; L3: 25MB

PCI-E 3 lanes 40

Memory controller Quad-channel DDR4, up to 128GB 2400MHz

Packaging LGA2011-v3

Thermal Design Power (TDP) 140W

Features Turbo Boost Max 3, Turbo Boost 2, Hyper-Threading, Virtualization (VT-x), Virtualization for Directed I/O (VT-d), VT-x with Extended Page Tables (EPT), Intel 64, Idle States, Enhanced SpeedStep, SmartResponse, Intel AES





There's a massive 25MB pool of shared L3 cache in the 10-core i7-6950X

ran Cinebench R15's 64-bit CPU test, which scales really well with the addition of more cores – the Core i7-6950X is over twice as fast as the i7-6700K here, and it's significantly quicker than the 8-core 6900K too. Likewise, the 10-core CPU's result of 11.8Hz in Euler 3D is superb.

If you run a lot of heavily multi-threaded rendering or video editing software, then you'll really benefit from a Broadwell-E chip. If you can afford to get the Core i7-6950X then no mainstream desktop CPU will be quicker – the multi-threaded performance is simply phenomenal.

Overclocking

As all the new Broadwell-E CPUs have unlocked multipliers, and are aimed at enthusiasts and overclockers, our next step was to see how far we could push their clock frequencies. Overclocking was one of our initial concerns, given the reports of poor overclocking from the original Broadwell desktop CPUs, but we're glad to say that these concerns were unfounded. Both the Core i7-6900K and i7-6950X can overclock to surprisingly high levels.

Despite having ten CPU cores crammed into its LGA2011-v3 package, the i7-6950X happily went all the way up to 4.4GHz, using a 1.3V vcore. At this clock speed, it absolutely stomped through our multi-threaded benchmarks, with a stunning score of 619,628 in Handbrake and 2,233 in Cinebench.

The resulting system score of 308,703 is incredible, being significantly in front of the 275,683 that currently tops our benchmarks leaderboard from a 5.5GHz Core i7-5960X.

However, while our test system was stable at these settings, the CPU temperature was very close to the thermal limit under our Corsair H115i cooler. You'll need some serious CPU cooling gear if you want to reach this clock speed comfortably. The 8-core 6900K was also happy to run at the same 4.4GHz frequency as the 10-core CPU, again with a 1.3V vcore, again providing a decent boost. The 8-core chip's overclocked Handbrake score of 523,699 is a great result.

Conclusion

There's no doubt that Broadwell-E rules the roost when it comes to multi-threaded CPU performance. The addition of two extra cores in the Core i7-6950X made it a formidable beast in our heavily multi-threaded Handbrake and Cinebench tests, and it's surprisingly overclockable too. What's more, its overclocked multi-threaded results are the fastest scores we've seen, even from heavily overclocked

CORE i7-6900K / SPECIFICATIONS

Frequency 3.2GHz

Turbo frequency 4GHz

Core Broadwell-E

Manufacturing process 14nm

Number of cores 8 x physical, 8 x virtual

Cache L1: 8 x 32KB instruction cache, 8 x 32KB data cache; L2: 8 x 256KB; L3: 20MB

PCI-E 3 lanes 40

Memory controller Quad-channel DDR4, up to 128GB 2400MHz

Packaging LGA2011-v3

Thermal Design Power (TDP) 140W

Features Turbo Boost Max 3, Turbo Boost 2, Hyper-Threading, Virtualization (VT-x), Virtualization for Directed I/O (VT-d), VT-x with Extended Page Tables (EPT), Intel 64, Idle States, Enhanced SpeedStep, Smart Response, Intel AES New Instructions

water-cooled Dream PCs. If you have the money, and you do a lot of heavily multi-threaded work, such as 3D rendering and video editing, then the Core i7-6950X is the fastest desktop CPU you can buy.

However, it comes with a ludicrous price tag – you could nearly buy four 6-core Broadwell-E chips for the price of a Core i7-6950X. Saying you've got a 10-core CPU might give you good bragging rights, but you pay a high price for the privilege.

Also, while Intel's new per-core overclocking features are likely to even up its single-threaded performance with the company's Skylake CPUs, it's unlikely to be any quicker than Skylake in these scenarios. If gaming performance is your

main priority, you'll be better off saving yourself some money and buying a chip with fewer cores.

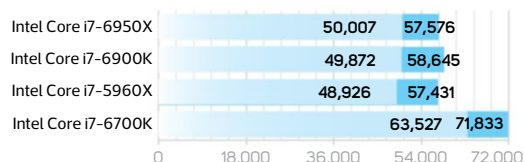
Likewise, while the 8-core 6900K's price isn't in the same league as that of the 6950X, it's still a lot of money for a CPU – you'll have to be really sure that you can use those eight cores before you part with the cash. We also recommend holding out until we've reviewed the 6-core Broadwell-E CPUs before getting your wallet ready.

If you have the money, though, and you want the best multi-threaded CPU performance on offer, there's no doubt about it, Intel's new Core i7-6950X is the fastest desktop CPU you can buy.

BEN HARDWIDGE

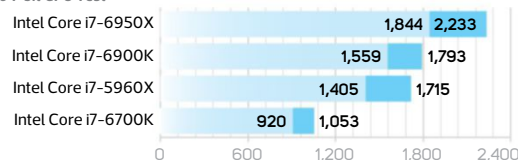
CPC REALBENCH 2015

GIMP IMAGE EDITING

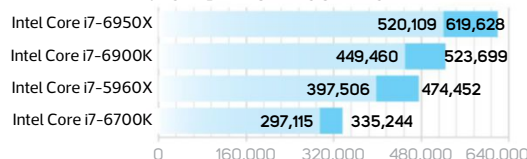


CINEBENCH R15

64-bit CPU Test



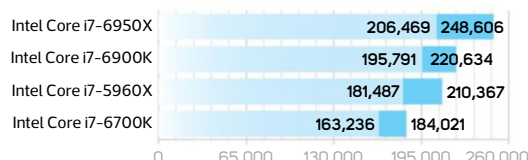
HANDBRAKE H.264 VIDEO ENCODING



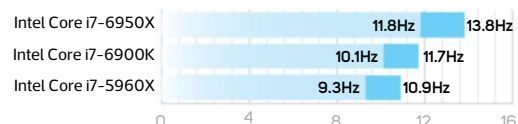
WPRIME 2.10 1024M (SECONDS)



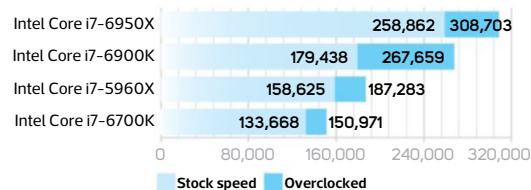
HEAVY MULTI-TASKING



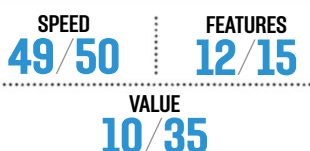
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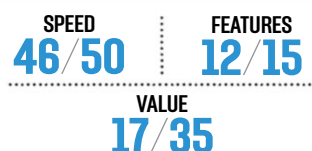
SYSTEM SCORE



CORE i7-6950X



CORE i7-6900K



VERDICT

Broadwell-E offers amazing performance, particularly in heavily multi-threaded software. However, you'll only see a benefit if your software properly uses many cores, and the Core i7-6950X's price is ridiculous.

/TEST KIT

Asus Rampage V Extreme 10 Edition motherboard, 32GB of Corsair DDR4 2666MHz memory, 6GB EVGA GeForce GTX 980 Ti graphics card, Corsair CX650M 2016 PSU, Corsair H115i CPU cooler, Intel 540 SSD, Windows 10 64-bit

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LGA2011-V3 ATX MOTHERBOARD

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SUPPLIER www.overclockers.co.uk

While Broadwell-E is backwards compatible with most X99 motherboards launched when LGA2011-v3 first landed in 2014, motherboard manufacturers have seen fit to refresh their X99 line-ups to add more features. Of course, the new ranges are compatible with Broadwell-E out of the box too, and don't require a BIOS update, so if you're building a new X99 system, boards such as Asus' new X99-A II mean you don't need to worry about your new CPU being recognised.

The X99-A II replaces the original X99-A, and most of the other boards in this range have been usurped too, including the Deluxe model. The X99-A II is more attractive than its predecessor, with a large white shroud now covering the rear I/O ports, and there are some subtle changes to the PCB and features too. Asus has included

dedicated 3-pin pump connectors for all-in-one liquid coolers on most of its Z170 motherboards and one is now present on the X99-A II, along with two fan headers, so it caters for most liquid-cooling systems now.

Asus is also clearly banking on RGB lighting being a killer feature this year,

and has not only included an on-board RGB LED in the chipset heatsink, but also put more underneath the audio circuitry and at the end of three of the 16x PCI-E slots too, which sport transparent slot levers to catch the light. In addition, there's also a standard 4-pin RGB header that can be used to control third-party RGB LED strips, so the X99-A II is one of the best boards we've seen for RGB lighting. As usual with Asus lighting, you can control it using the included Aura software and also choose from a variety of lighting effects, as well as having the ability to switch off the lights.

The primary 16x PCI-E slot also includes a feature that Asus calls SafeSlot technology, which is essentially the

company's version of some of the reinforced PCI-E slots we've seen recently; it claims better retention force and nearly twice the shearing strength of a standard slot. In terms of multi-GPU setups, the X99-A II supports up to three-way SLI or CrossFire configurations. With a 40-lane CPU such as the Core i7-5960X or the new Core i7-6950X (see p19), for example, two-way setups get the full 16 lanes of bandwidth in both slots, although Asus has lowered the bandwidth available for three-way setups from 16x/16x/8x to 8x/16x/8x with the new board, as two of these slots now share bandwidth.

Its predecessor saw the third full-speed slot share bandwidth with the M.2 port, so this arrangement seems



like a good compromise, given that M.2 SSDs are becoming popular in system builds, while three-way GPU systems are extremely rare. The board still caters well for three-way GPU setups in terms of slot spacing, though, with 1x PCI-E slots double-spacing the primary 16x slots for extra clearance – handy for large, air-cooled graphics cards.

Sadly, there's no clear-CMOS switch, but the rest of the usual overclocking tools are present and correct, including power and reset buttons – albeit small ones, plus an LED POST code display. The X99-A II also has a 2-pin thermal sensor connector, plus three case fan headers, with one of the latter providing up to 3A of current for either multiple fans or a single high-power fan, with Smart Protection circuitry on hand to prevent over-current, just in case.

The X99-A II also sports all the major storage standards, including ASMedia-controlled USB 3.1 Type-A and Type-C ports, M.2 and U.2 ports plus SATA Express and ten SATA 6Gbps ports.

Asus has also updated its software suite and EFI, which now include Fan Xpert4 plus a Turbo Core app that can tap into the new Turbo Boost Max 3 technology in Intel's new Broadwell-E CPUs, as well as their per-core overclocking capabilities. The EFI looks much the same as that on Asus' previous mid-range X99 boards, with a clear layout and appealing colour scheme, but it's good to see that SSD Secure Erase has been included, which was once a ROG-only feature.

Performance

Out of the box, the X99-A II's overall performance was good, with a system score of 166,626 performing similarly to the Asus Sabertooth X99 and faster than MSI's X99S SLI-Plus. Its comparatively slow result in the image editing test was also swept under the rug thanks to excellent scores in the other tests, while in the other benchmarks it was on par with the competition.

Overclocking the CPU was fairly easy and just required a vcore of 1.36V to reach 4.4GHz. However, we had to



SPECIFICATIONS

Chipset Intel X99

CPU socket Intel LGA2011-v3

Memory support 8 slots: max 128GB DDR3 (up to 3333MHz)

Expansion slots Three 16x PCI-E 3, one 16x PCI-E 2, three 1x PCI-E 2

Sound Realtek ALC1150

Networking Intel I218-V Gigabit LAN

Overclocking Base clock 80–300MHz, CPU multiplier 12–80x; max voltages, CPU 1.92V, RAM 1.9V

Ports 10 x SATA 6Gbps (Z170), 1x SATA Express 6Gbps, 1x M.2, 1x U.2, 8 x USB 3, 1x USB 3.1 Type-A, 1x USB 3.1 Type-C, 8 x USB 2, 1x LAN, 3 x surround audio out, line in, mic

Dimensions (mm) 305 x 244

- 1 On-board power and reset switches are included, along with an LED POST code display
- 2 Unlike its predecessor, the X99 A-II has a large white shroud over the rear I/O ports
- 3 The primary 16x PCI-E slot features Asus' SafeSlot reinforcement system

manually tweak the timings of our test memory, as the XMP profile didn't quite set them correctly. Once overclocked, the performance was much more consistent.

With the CPU running full whack, performance was quicker than Asus' Sabertooth X99, with the exception of our Shogun 2: Total War test where its minimum frame rate was 1fps behind – a very small difference. Audio was on a par with most boards we've seen recently too, with noise and dynamic range levels of -104.5dB(A) and 104.2dB(A) respectively. Meanwhile, SATA 6Gbps read and write speeds of 527MB/sec and 499MB/sec, and M.2 read and write speeds of 2,300MB/sec and 960MB/sec were on the ball too, as was power consumption.

Conclusion

The X99-A II is a polished example of an X99 motherboard. While it might not be the best option for three-way graphics setups, it sports all of Asus' software features, which are extensive, plus some extra features such as RGB lighting, U.2 and has the addition of both USB 3.1 Type-A and Type-C ports, which were absent from the original board. The price

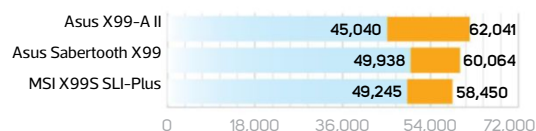


is higher than some of the cheaper X99 offerings, which can be found for less than £180, but if you want a great-looking X99 motherboard with RGB lighting and all the latest storage standards and software features, the X99-A II is a great buy.

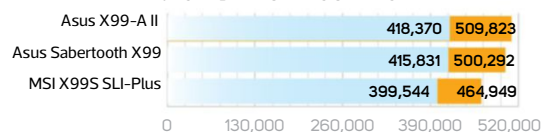
ANTONY LEATHER

CPC REALBENCH 2015

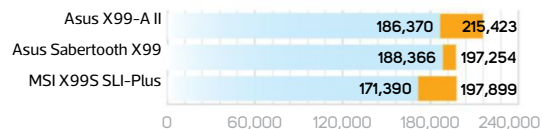
GIMP IMAGE EDITING



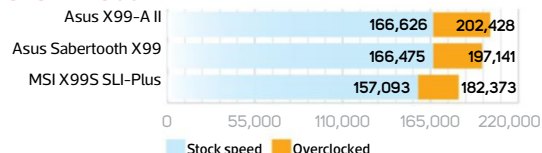
HANDBRAKE H.264 VIDEO ENCODING



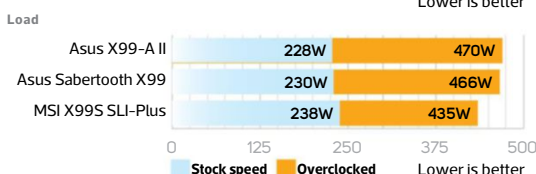
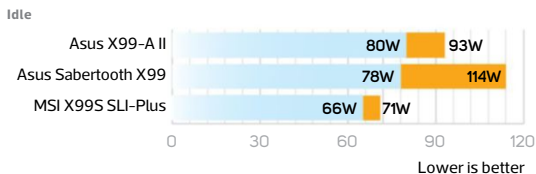
HEAVY MULTI-TASKING



SYSTEM SCORE

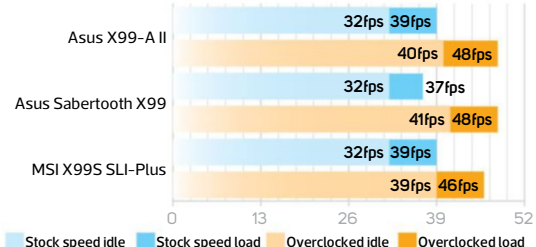


TOTAL SYSTEM POWER CONSUMPTION



SHOGUN 2: TOTAL WAR CPU TEST

1,920 x 1,080, default settings, no AA, no AF



SPEED
37/40
VALUE
23/30

FEATURES
27/30

OVERALL SCORE
87%

VERDICT

The X99-A II is a great motherboard with loads of modern features, which help to justify its premium over some of the cheaper X99 boards available

/TEST KIT

3GHz Intel Core i7-5960X, 32GB Crucial 2133MHz DDR4 memory, 256GB OCZ Arc 100 SSD, Corsair HX860i PSU, Windows 10 Home 64-bit

GRAPHICS CARD

Nvidia GeForce GTX 1080 Founders Edition / £619 inc VAT

SUPPLIER www.scan.co.uk

Writing this review has involved an awful lot of double-takes and having to double-check some of our figures. From the super-fast frame rates to the surprisingly low power consumption, there have been quite a few moments where we've said 'hang on, that can't be right'. But sure enough, the GTX 1080 is indeed a feat of silicon engineering that stomps over all its predecessors. Likewise, the price will stomp all over your bank balance and, as with the performance figures, we've double-checked it – this new graphics card does will indeed set you back £619 inc VAT.

It can use ray tracing principles to simulate sound moving in VR space

Cheaper cards may appear on the horizon in the near future though. Nvidia has chosen an interesting strategy with the GTX 1080 launch, which is to brand cards with its reference cooler as 'Founders Edition' cards. Nvidia says it's seen very strong demand for its reference cards, especially as some GPU series weren't available with reference coolers at retail – customers reportedly wanted to be able to buy reference cards all the time, rather than having them limited to rare review samples. It's easy to see why.

Nvidia's reference coolers look great, with their light-up logos, and they're also quiet. What's more, if you get a



reference card, you know your PCB will have a standard layout that's more likely to fit third-party cooling gear, such as waterblocks.

For the moment, the Founders Edition cards are the only ones available in the shops, and it looks as though they're going to demand a premium over some GTX 1080 cards from board partners. So what does £619 buy you? The GTX 1080 brings a lot of new goodies with it, not least the new Pascal architecture. It's the first GPU to be manufactured using 16nm FinFET transistors, which has enabled Nvidia to squeeze loads more transistors into its GPU package – 7.2 billion of them, in fact.

Peeking into Pascal

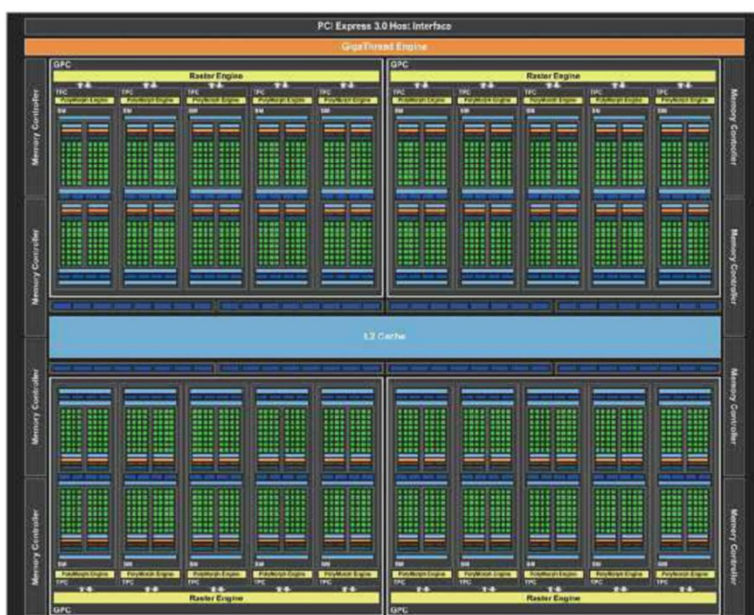
This complicated silicon maintains Nvidia's previous system of splitting its GPUs into graphics processing clusters (GPCs), each containing several units of streaming multiprocessors (SMs). In this case, there are four GPCs, eight 32-bit memory controllers (256-bit total) and 20 SMs, each comprising 128 stream processors, making for a grand total of 2,560 stream processors.

As a point of comparison, the GeForce GTX 980 Ti has 2,816 stream processors, while the Titan X has 3,072 of them. However, thanks to Nvidia's other changes, the company is confident that the GTX 1080 will outperform both cards, and will even outperform a pair of GTX 980 cards in SLI configuration. Elsewhere, the GPU's specs offer 20 geometry units, 160 texture units and 64 ROPs.

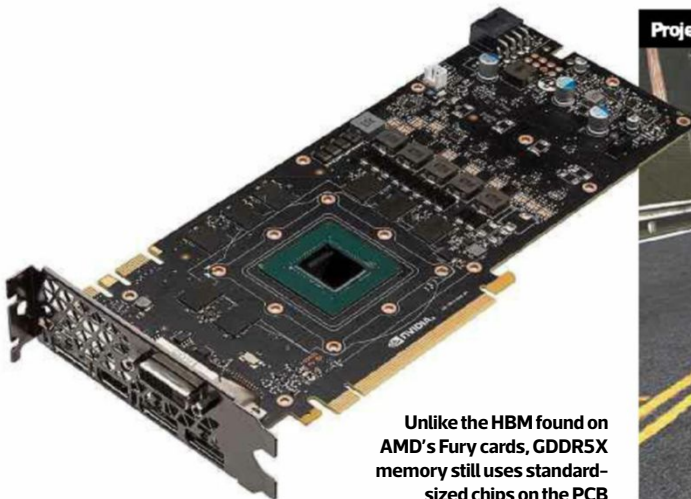
One bonus the GTX 1080 has over its predecessors is clock speed. Its core has a base clock of 1.61GHz, boosting to 1.73GHz. That's a big jump from the GTX 980 Ti's 1GHz core clock, but the memory has seen an even bigger leap in clock speed. The GTX 1080 sees Nvidia moving to GDDR5X memory via a 256-bit memory interface, which in this case is clocked at 10000MHz (effective) – that's a massive leap in bandwidth from the 7010MHz GTX 980 Ti's memory.

New memory

GDDR5X memory still comes in the form of standard chips on the PCB though – it's not like the tiny High Bandwidth Memory AMD uses on its Fury cards, which can be mounted on the GPU package. As such the GTX 1080 is still a beast of



The GTX 1080 features 20 streaming multiprocessors, each containing 128 stream processors, for a grand total of 2,560 stream processors



Unlike the HBM found on AMD's Fury cards, GDDR5X memory still uses standard-sized chips on the PCB



a card, measuring 267mm across, although you do get a huge allocation of 8GB of memory, compared with just 4GB of HBM on AMD's Fury cards.

Nvidia has also tweaked the GTX 1080's memory management to get the most out of the extra bandwidth of GDDR5X memory, from designing new PCB channels to changing its compression system. The company claims its new lossless data colour compression system between the memory and the GPU can result in a 20 per cent improvement in memory performance.

Put simply, the new compression system reduces the amount of colour data that needs to be transferred between the GPU and memory the bare minimum.

Nvidia gives an example of a red colour having a value of 25,500, and the next colour having a value of 25,000 – instead of sending all the colour data again for the next colour, the new data colour compression system will just send the -5 difference.

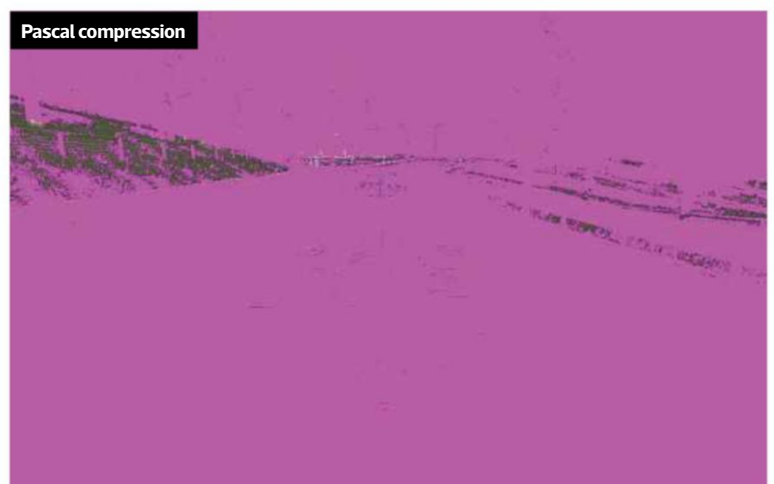
New interfaces

Another area that's had a bit of an overhaul is Nvidia's SLI interface, particularly for systems with more than two GPUs. Put simply, with Nvidia's previous GPUs, you had to effectively combine two independent two-way SLI interfaces. With the GTX 1080, multiple GPUs can now be linked properly together using a new dual-link SLI mode, increasing the bandwidth between the GPUs. The company has introduced a set of new SLI bridges (SLI HB) to accommodate the new mode. You can still use old SLI bridges with GTX 1080 setups, but you'll only be able to use the new dual-link mode with an SLI HB bridge.

One more new interface worthy of note is HDMI 2b, which basically increases the bandwidth available when compared with HDMI 2. This extra bandwidth enables you to display full 10-bit colour at 4K with a 60Hz refresh rate, with the 10-bit colour enabling the card to output full HDR imagery to a TV or monitor with 10-bit colour. In addition, the GTX 1080 supports hardware HEVC decode, with support for 4K Netflix content, as well as other 4K streaming services.

What else is new?

Nvidia is introducing a lot of new features with Pascal, and not all of them are related to raw graphics processing. One neat new idea is Ansel, a feature that enables you to take



very fancy screenshots. Rather than being limited to your player character's view of a game, Ansel effectively gives you a free camera to take a shot of any part of a scene.

Like photo editing software, it can also offer post-processing filters, exposure adjustment, a 360-degree photo feature and a technology called SuperRez to remove sharp edges.

Ansel integrates with Nvidia's driver, using a UI overlay, and the idea is that it will be integrated into games as a standard feature – Nvidia says it's easy to integrate into a game without using much code.

Pascal introduces a new compression system, reducing the amount of colour data sent between the memory and the GPU to improve bandwidth further



Nvidia's new Ansel technology aims to enable you to take fancy screenshots from any perspective with a free camera



Nvidia is also focusing on the demands of VR gaming with its VRWorks tech, and one particularly interesting new feature is VRWorks audio. Getting audio right in VR is currently hard, and often limited to a stereo headset. While standard 5.1 and 7.1 surround systems are great if you're in a static position in front of a TV, audio becomes much more complicated when you can move around in a virtual room, turning your head from side to side.

The idea behind VRWorks audio is that it can use ray tracing principles to simulate how sound moves in your VR space, accounting for not only the position and volume level, but also reflection, absorption, occlusion, diffraction and so on. We haven't had a chance to play with it yet, but a demo called Nvidia Fun House will soon be coming to Steam VR, and we look forward to trying it out for ourselves.

Performance

So, on to the big question, just how fast is the GTX 1080? The answer, in case you haven't already looked at the performance graphs, is very fast. It goes without saying that 1080p and 2,560 x 1,440 gaming are no problem for this card – in most of our test games, the GTX 1080 never dropped below 60fps at these resolutions – one exception is Fallout 4 at 2,560 x 1,440, but even then, the minimum of 56fps is very smooth.

You're not going to buy a GTX 1080 for gaming at these resolutions though. The key resolution is 3,840 x 2,160, and here the GTX 1080 really shines, staying above 30fps in all our standard tests, and producing a stunning minimum of 50fps in Doom at Ultra settings, and 43fps in The Witcher 3 at High detail. We wanted to see how far we could push it, and found that the GTX 1080 could still run The Witcher 3 at 4K at Ultra settings with HairWorks enabled, and the game still didn't dip below 30fps. Again, the only outlier was Fallout 4, but even that game remained borderline playable at Ultra settings – a result we've never seen from a single GPU before.

Even Crysis 3 wasn't fazed by the GTX 1080, with a 4K minimum of 37fps at Very High detail. As our resident grumpy old man James Gorbald will happily tell you on p114, the GTX 1080 is only borderline playable in some other titles at 4K, as opposed to offering super smooth frame rates, but it offers by far the best single-GPU 4K performance we've seen yet. If you want to play 4K games without mucking around with multi-GPU tech, then the GTX 1080 is the card for you.

We then had a go at overclocking the GTX 1080, and it remained happy after we added 275MHz to the GPU core clock and 200MHz to the memory frequency, which brought the Crysis 3 4K frame rate up to a minimum of 39fps (with the core peaking at 2050MHz). Despite this overclock, the core temperature didn't get any higher than 82°C (a delta T of 57°C), which was the same result at its stock speed – the fan speeds up to deal with the extra heat with no problem at all, and it does it quietly too.

Perhaps more astoundingly, though, the power consumption at full load only increased by 3W when overclocked, and the total system power consumption when running Unigine Valley was already low at just 306W at stock speed.

Comparably, our system drew 386W from the mains at load with a GTX 980 Ti installed, and 412W with a Radeon R9 Fury X installed – that's a significant drop in power consumption, particularly when you consider the extra performance – the GTX 1080 also only requires a single 8-pin power connector. The GTX 1080's power consumption is much closer to the GTX 980 or Radeon R9 380 than the cards it outperforms.

Conclusion

Nvidia's Pascal architecture is a phenomenal technical engineering achievement from Nvidia, managing to play all our test games at 4K without dropping below 30fps, and even making The Witcher 3 playable at Ultra settings.

It's a significant step up from the best Maxwell desktop chips in terms of performance, and it combines this speed

/SPECIFICATIONS

Graphics processor Nvidia GeForce GTX 1080, 1607MHz (1733MHz boost)

Pipeline 2,560 stream processors, 64 ROPs

Memory 8GB GDDR5X, 10GHz effective

Bandwidth 320GB/sec

Compatibility DirectX 12, OpenGL 4.5

Outputs/inputs Dual-link DVI, 1x HDMI 2b, 3x DisplayPort 1.4

Power connections 1x 8-pin

Size 267mm long, dual-slot

with fantastic power efficiency. It's undoubtedly the current GPU king.

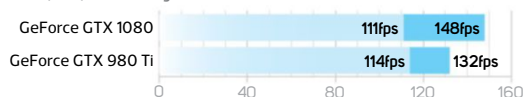
The only sore point is the price, with the Founders Edition cards costing nearly £200 more than the cost of GTX 980 cards at launch. Even GeForce GTX 980 Ti cards were cheaper at launch. We like Nvidia's reference cooler, but

we're not sure we like it that much. If you're in the market for a GTX 1080, we'd advise waiting for a month or so to see if you can save yourself some money by buying a third-party card, and also waiting to see what the forthcoming GTX 1070 (see p14) will be able to offer you.

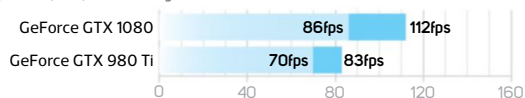
BEN HARDWIDGE

DOOM

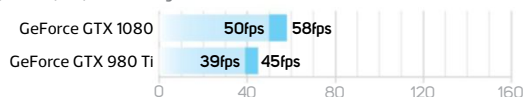
1,920 x 1,080, Ultra settings



2,560 x 1,440, Ultra settings

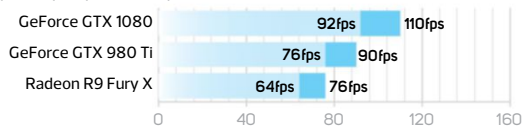


3,840 x 2,160, Ultra settings

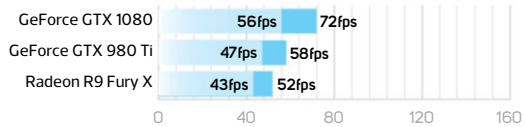


FALLOUT 4

1,920 x 1,080, Ultra detail, TAA



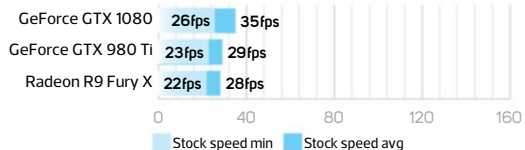
2,560 x 1,440, Ultra detail, TAA



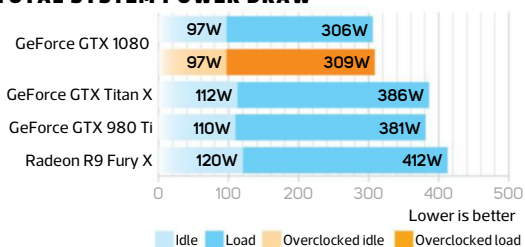
3,840 x 2,160, High detail, TAA



3,840 x 2,160, Ultra detail, TAA

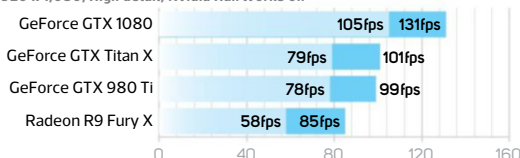


TOTAL SYSTEM POWER DRAW

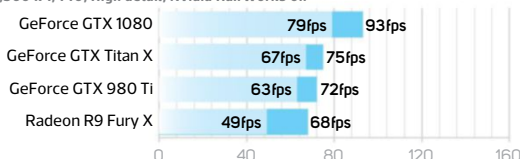


THE WITCHER 3: WILD HUNT

1,920 x 1,080, High detail, Nvidia HairWorks off



2,560 x 1,440, High detail, Nvidia HairWorks off



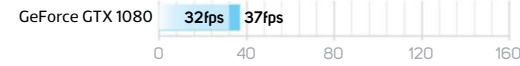
3,840 x 2,160, High detail, Nvidia HairWorks off



3,840 x 2,160, High detail, Nvidia HairWorks on

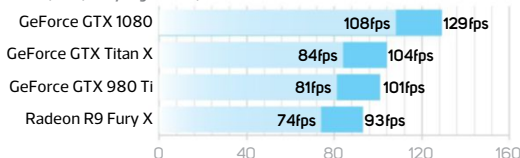


3,840 x 2,160, Ultra detail, Nvidia HairWorks on

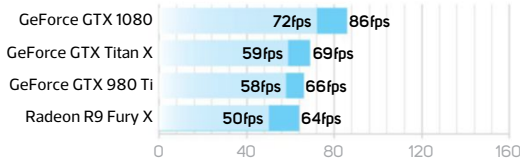


CRYSIS 3

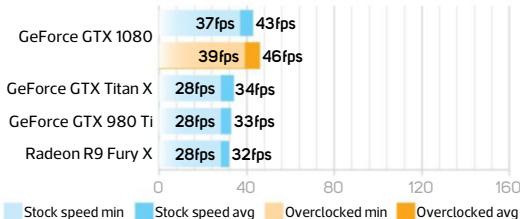
1,920 x 1,080, Very High detail, 0x AA



2,560 x 1,440, Very High detail, 0x AA



3,840 x 2,160, Very High detail, 0x AA



SPEED
50/50
EFFICIENCY
10/10

VALUE
17/40

OVERALL SCORE
77%

VERDICT

The new GPU king is here. The GTX 1080 combines incredible 4K gaming speed with fantastic power efficiency, but this first round of cards is very expensive.



Performance without compromise



Spectre Lite

- AMD FX-4300
- ASUS® M5A97 R2.0
- 8GB HyperX FURY RAM
- 2GB NVIDIA® GeForce® GTX 950
- 1TB Hard Drive
- Corsair 350W PSU
- **Windows 10**
- 3 Year Standard Warranty

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- ASUS® Maximus VIII Hero
- 8GB HyperX FURY RAM
- 2GB NVIDIA® GeForce® GTX 960
- 1TB Hard Drive
- Corsair 450W PSU
- **Windows 10**
- 3 Year Standard Warranty

THIS SPEC FROM

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Vitrum

- Intel® Core™ i5-6600K
- ASUS® Z170-E
- 16GB HyperX FURY RAM
- 4GB NVIDIA® GeForce® GTX 970
- 400GB Intel® 750 PCIe SSD
- 1TB Hard Drive
- **Windows 10**
- 3 Years Warranty

THIS SPEC FROM

£1,199*



Glacier

- OC Intel® Core™ i7-6700K
- ASUS® Maximus VIII Hero
- 16GB Corsair Vengeance RAM
- 6GB NVIDIA® GeForce™ GTX980Ti
- 400GB Intel® 750 PCIe SSD
- 2TB Hard Drive
- **Windows 10**
- 3 Years Warranty

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- Intel Integrate Graphics
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- Full HD IPS Screen
- Up to 7.5 Hours Battery
- Wireless as standard
- **Windows 10**
- 3 Year Standard Warranty

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- ASUS® Maximus VII Ranger
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- 3 Year Standard Warranty

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ATX CASE

In Win 303 / £85 inc VAT

SUPPLIER www.overclockers.co.uk

Last month we reviewed a £300 glass and aluminium case from In Win – the 909. This month, it isn't just the name that's had two thirds lopped off it though; the price has been similarly slashed too. In fact, the new 303 costs even less than a third of the 909's cost at just £85 inc VAT. Despite the surprisingly low price tag, though, the 303 still sports In Win's familiar glass side panel, albeit only on one side.

Unlike In Win's 805, the 303 is a little more subdued, using steel rather than aluminium construction, and it weighs an extra kilogram as a result, but it's far from being too heavy. It's also very square-looking, largely due to the front panel lacking any mesh, fan grilles or plastic. The only feature on the front is the array of front panel buttons and

ports, which includes two USB 2 and two USB 3 ports, audio mini-jacks, plus power and reset buttons. These buttons, along with a 3in In Win logo, can be illuminated too.

The side panel is part glass, part plastic, and provides a fantastic view of the interior through its slightly opaque finish. There are no thumbscrews here, as we saw on the 805 and 909. Instead,

the 303 uses a pop-open latch at the top of the panel, which is much quicker and easier to use than thumbscrews. The latch was a little stiff on our sample, although it became a little looser after using it a few times. The case is also lifted aloft by an inch or so by two large plastic feet, which breaks up the angular exterior while allowing air to be drawn into the case through a huge bottom vent, which is equipped with a large detachable dust filter.

Meanwhile, the far side panel is made from steel, but thankfully it's not just your average plain panel. It's been perforated with a hexagonal design that acts as an exhaust vent. The rear of the case reveals a very different layout to your average ATX tower too. The final expansion slot bracket is located right at the bottom, so routing tubing from a water-cooled graphics card will need careful consideration.

Then there's the PSU mount, which is located in the roof and has been up-ended, adding to the case's height, which stands at 50cm. Take a look inside, though, and it's immediately obvious why the case is laid out in this way.

There's a trio of 120mm fan mounts staring at you in a hexagonal mesh in the roof, and all the rest of the hardware is located below them. The space can be used for fans, but it's more useful for locating triple radiators with 120mm fans – there's space for 30mm thick radiators, plus a single row

of fans with an inch or so of clearance. It's a handy location for a radiator, as it can exhaust its warm air through the side panel vents, although one fan will undoubtedly be pointing at your PSU. Even so, the roof can also play host to a pump and it makes a great place to stow PSU cables, which is just as well, as the motherboard tray doesn't offer many cable anchoring points.

The base of the case sports a further three 120mm fan mounts, although your choice of motherboard will dictate what radiator you can fit here. The only fan included with the 303 is a rear 120mm exhaust fan – clearly, the 303 is aimed at people with all-in-one liquid coolers or custom water-cooling loops. To bolster these credentials, there's also a reservoir mount next to the motherboard, and plenty of space at the front of the case, which is devoid of front fan or drive mounts.

The 303 caters well for storage, though, thanks to four drive mounts – two dedicated 2.5in mounts for SSDs and two dual-purpose mounts that can home either SSDs or hard disks. Building a system in the 303 is relatively easy, although there's only just enough space for an ATX motherboard beneath the top chamber and just 160mm clearance for CPU coolers. The rear side panel also lacks enough room to comfortably house large power connectors, such as SATA and Molex plugs, but otherwise, the rest of the case works well and build quality is excellent.

Performance

We suspected that the low position of the motherboard, and therefore the graphics card, might shave a few degrees off the 303's temperatures and it did indeed perform well considering it has only one fan. Its included fan shifted a reasonable amount of air too, but thankfully, it was also very quiet. Its CPU and GPU delta T's of 54°C and 52°C respectively were enough to see off the Phanteks Eclipse P400S convincingly, although the Fractal Design Define S was slightly better in both tests, probably because it has more fans. The same was true for the NZXT H440 2015 Edition, but the difference was just 1°C in both tests. Overall,

Its fan shifted reasonable airflow, and was thankfully also very quiet

/SPECIFICATIONS

Dimensions (mm) 215 x 480 x 500 (W x D x H)

Material Steel, plastic, glass

Available colours Black, white

Weight 10.9kg

Front panel Power, reset, 2 x USB 3, 2 x USB 3, stereo, mic

Drive bays 2 x 3.5/2.5in, 2 x 2.5in

Form factor(s) ATX, micro-ATX, mini-ITX

Cooling 3 x 120mm side/roof fan mounts (fans not included), 1 x 120mm rear fan mount (fan included), 3 x 120mm base fan mounts (fans not included)

CPU cooler clearance 160mm

Maximum graphics card length 350mm



- 1 The PSU mount has been up-ended and moved to the roof
- 2 There's space for a triple 120mm radiator in the roof
- 3 The final expansion slot bracket is located right at the bottom



the 303 is a capable case when it comes to air cooling, and the addition of a single roof and base fan would likely make it even more potent.

Conclusion

The 303's best asset is that it's interesting. It's a far cry from run-of-the-mill ATX tower cases and, once again, In Win has dared to be different and largely succeeded. It's a great case for water cooling, although the side vents could be a little larger. Otherwise, there's plenty of room for radiators, pumps and reservoirs – the only potential issue could be

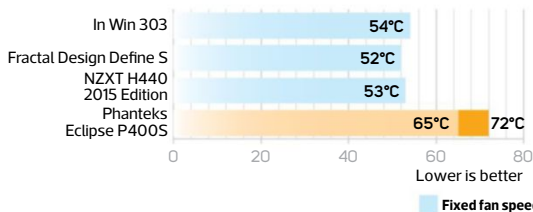
with multi-GPU setups, due to the proximity of the lower card to the base of the case. The 303 also performed very well as an air-cooled case.

Our only major qualm was with the cable routing. It needs more room for large connectors, and more anchor points and cable ties – you'll almost certainly need to buy some ties to build a tidy system.

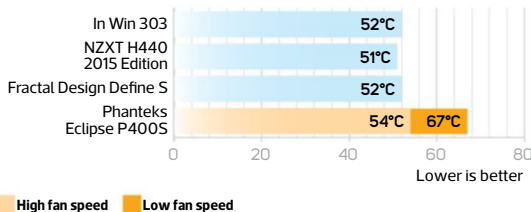
Otherwise, though, if great looks and room for water-cooling gear are your priorities, the 303 is an interesting case that offers plenty of expansion and great value for money.

ANTONY LEATHER

CPU LOAD DELTA T



GPU LOAD DELTA T



COOLING
27/30
DESIGN
25/30

FEATURES
16/20
VALUE
17/20

OVERALL SCORE
85%

VERDICT

In Win has done it again with the 303, which is a unique, interesting and water-cooling friendly case for less than £90.

WATER-COOLING KIT

XSPC RayStorm Pro Ion AX240
WaterCooling Kit / **£160** inc VATSUPPLIER www.overclockers.co.uk / MODEL NUMBER 5060175587077

Understanding and identifying all the components you need to construct a complete water-cooling system can seem quite daunting for the first time, and it isn't surprising that all-in-one liquid coolers have been so popular as a result. Custom kits still hold the ultimate in cooling prowess and aesthetics, though, and while EKWB's Predator blurred the lines between custom and ready-made systems, complete kits such as XSPC's RayStorm Pro Ion AX240 bundle allow you to dive into proper custom water-cooling hardware with a minimum of fuss.

The RayStorm Pro Ion AX240 kit includes all the parts you need to water-cool your CPU, except coolant, which is included in all-in-one kits such as the EKWB Predator. The latter can be dismantled to use your own coolant, and even expanded to add other blocks into the loop, although such jobs aren't easy when compared with a fully custom kit such as the RayStorm Pro Ion AX240.

You get 2m of clear 7/16in ID (inner diameter) tubing – plenty for cooling just your CPU, and six black chrome compression fittings – enough to connect the pump, radiator and CPU waterblock together. To add a graphics card to the loop, all you need are two additional compression fittings that cost a couple of quid each, plus a GPU waterblock. Meanwhile, the pump is an

Unlike nearly every all-in-one liquid cooler, the Ion has a large side window

XSPC Ion, which is a combined pump and reservoir. It's not quite as powerful as your average Laing-based pump, but we've found that it offers plenty of grunt for your average system and it's fairly quiet too.

The Ion is encased in attractive aluminium housing and has a choice of two inlets or a single outlet, all with great-looking, chrome-plated ports, along with a large fill port on top. Unlike nearly every all-in-one liquid cooler, the Ion has a large side window, so while it's fairly small, you get to see your fancy coolant. Similarly, the kit's tubing is clear too.

The kit is compatible with all current Intel CPU sockets, and XSPC has bundled its RayStorm Pro CPU waterblock, which looks fantastic and includes two LEDs that can illuminate an acrylic insert that runs around the ports. The pump also has an LED, and all the LEDs are powered by 4-pin Molex cables.

There are several versions of the kit available, with the main difference being the size of the radiator included. Our sample sports a 40mm-thick model from XSPC's AX-series, which includes two 3-pin 120mm fans. These fans spin at 1,650rpm as standard – slower than the monstrous 2,200rpm fans included with the Predator, but they're significantly quieter at full speed as a result.



The resulting airflow will still be enough to cool an overclocked CPU and, at full speed, they'll be able to tame a high-end graphics card added to the loop too.

Then there's the radiator itself, which is housed in an attractive aluminium shell that has the same chrome-plated ports as the Ion pump. It also has a more durable paint finish than many third-party radiators, and its standard size make it easier to install than the Predator's Radiator too. You can mount the radiator in a variety of ways. It measures 65mm deep with fans, so it should fit in the roof or front of many cases with dual 120mm fan mounts. Screws are provided for push or pull setups in both of these locations, either mounting the radiator fan first or radiator first. XSPC has also included radiator mounts that enable you to fit it externally to your case using an accessible fan mount.

The pump is even more flexible as its mount can be rotated, and it fits to any 120/140mm fan mount; you could even mount it on the radiator. It's certainly handy not needing to find somewhere special in the case for it, as it means the pump can be fitted in a large range of cases, including some small ones.

The kit also includes thermal paste, fan grilles and an ATX jumper. You can use the latter to jump-start your PSU without any of your hardware powered on. By just connecting the pump, you can then fill the water-cooling system with coolant and leak-test it without risk of damaging your hardware if a leak occurs.

Finally, the key to this kit is the instruction manual. It isn't quite specific to the kit in question, but every component is included and it's simple to see how to mount the waterblock, fans or radiator. It walks you through the entire process of building and filling the loop as well as leak testing and troubleshooting – great for beginners.

Performance

We suspected the powerful pump and higher speed fans in the EK Predator kit would enable it to pull out a lead over the XSPC RayStorm Pro Ion AX240, but the difference was very slight in both our LGA1155 and LGA2011 systems. It was just 2°C and 1°C off the pace respectively – practically within the margin of error – and it produced a lot less noise. As the fans lack the EK Predator's PWM control, we'd still advise hooking up the fans to your motherboard if it supports 3-pin

/SPECIFICATIONS

Compatibility Intel: LGA115x, LGA1366, LGA2011, LGA2011v3

Radiator size (installed) (mm) 128 x 286 x 40 (W x D x H)

Fans 2 x 120mm, 1,650rpm

Stated noise 29dB(A)



fan control, or using a fan controller or resistor cables, but the XSPC kit's noise is far from unpleasant at full speed.

The RayStorm Pro Ion AX240 kit was significantly better than the other all-in-one liquid coolers we've tested too, with a 7°C lead over the Corsair H110iGT in our LGA1155 system and a 6°C lead in the LGA2011 results.

Conclusion

The XSPC RayStorm Pro Ion AX240 kit offers the full cooling capabilities of a fully custom water-cooling system, and has every part you need, including detailed instructions and leak-testing tools, except for coolant. All the components look fantastic too – much better than the more expensive

1
The detailed instructions walk you through the entire process

2
The windowed Ion reservoir is encased in attractive aluminium housing

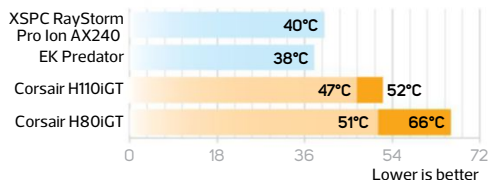
3
Our review sample sports a 40mm-thick AX-series radiator

EKWB Predator and any all-in-one liquid cooler we've reviewed as well.

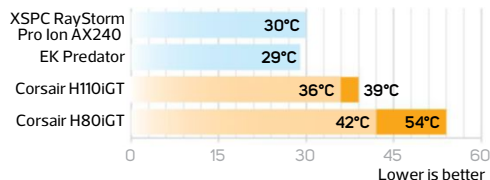
While the price is high, the kit will likely be compatible with many future generations of CPU sockets, plus it's easy to add a graphics card and change coolants too. If you don't mind spending a few extra hours installing it, this kit offers a great introduction to the dark art of PC water cooling.

ANTONY LEATHER

INTEL LGA1155



INTEL LGA2011



LGA115x

COOLING 37/40
DESIGN 27/30
VALUE 26/30

OVERALL SCORE
90%

LGA2011

COOLING 36/40
DESIGN 27/30
VALUE 26/30

OVERALL SCORE
89%

VERDICT

An almost complete introduction to proper custom water cooling, with great-looking components and detailed instructions.



LOUNGE GAMING DEVICE

Corsair Lapdog / **£110** inc VATSUPPLIER www.scan.co.uk

The lounge has long been a target of the PC gaming industry, but it's never quite cracked it. However, Corsair is hoping its Lapdog, along with some other products, such as its Bulldog mini-ITX gaming chassis, could make gaming from your sofa more practical. Several iterations of the Lapdog will be available, including keyboard and mouse bundles, but it will also come as a vacant unit as reviewed here. The idea is simple; the Lapdog provides a secure home for one of Corsair's K70 or K65-series keyboards and offers a large mouse mat, all in a chassis with a cushioned base designed to sit on your lap.

The base is magnetic, enabling you to quickly remove it to access an Allen key tool in a small compartment, which can then open up certain areas of the top section to route cables and install a keyboard. You can, of course, ditch the cushioned base if you prefer. In theory, you could also swap the Lapdog between your sofa and desk and even carry the Lapdog to a LAN party,

although Corsair doesn't seem to have considered desk use an option, as there are no anti-slide pads on the underside.

The Lapdog features plastic and aluminium construction, with the mouse mat and aluminium keyboard surrounds coming away to reveal a hollow interior and powered USB 3 hub. A 5m combined power and USB 3 cable runs from your PC to the Lapdog, with a detachable power adaptor at the other end too. The Lapdog has four USB 3 ports – two external and two internal.

The keyboard and mouse use the internal ports, with a small hole available to route the mouse cable out of the Lapdog at the top left of the mouse mat. Alternatively, it could house a storage device inside the Lapdog, potentially

enabling you to carry your game backups with you and use one of the external ports for your mouse.

Corsair's K70 RGB keyboard slots beautifully into the lapdog. There's no movement whatsoever and the Lapdog's chassis sits at the same height of the keyboard, so accessing the keys isn't a problem. The mouse mat, meanwhile, is made from a single piece of aluminium and has a textured surface – it's easy to use while you're sitting on a sofa, and the keys are well positioned too.

However, there's one big issue with the Lapdog, which is the lack of a wrist rest. The bottom edge of the keyboard surround is quite sharp, which can make using it uncomfortable. The angle here is reduced if you lay back into a sofa, but we still found it awkward to use. Even rounding off the edge, as Corsair has done with other areas of the device, would be an improvement.

Conclusion

The Lapdog has the potential to be a great sofa gaming device and we hope Corsair continues developing the idea to make it more flexible. For example, it wouldn't take much work to make it easily switchable between your sofa and desk. However, in its current form, the wrist area needs urgent attention as the sharp edge is very uncomfortable.

ANTONY LEATHER

It features plastic and aluminium construction



DESIGN **30/40** | FEATURES **24/30** | VALUE **21/30**

OVERALL SCORE
75%

VERDICT

The Lapdog is the best attempt we've seen yet at bringing PC gaming to the lounge, but it needs some ergonomic improvements.



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Custom Kit

Paul Goodhead checks out the latest gadgets, gizmos and geek toys

BLUETOOTH LOCK

Noke / **£60** inc VAT

The Noke (pronounced 'no key', geddit?) is a Bluetooth padlock. It's a concept that may sound odd at first, but it really makes sense when you put it to use, as every aspect of its operation is very well considered. You pair the lock to a phone, and you can then unlock the padlock with a squeeze if the phone is within Bluetooth range. If your phone runs out of battery, then you can alternatively just tap in the code of short and long squeezes you created when you set up the lock.

The slick companion app shows you the location and time of each use, so you can see if anything is awry, and you can share access with other people too, although they'll need to install the app. It isn't perfect (replacement batteries are needed once a year), and £60 is expensive whichever way you cut it, but it's an innovative, futuristic, thoughtfully designed and genuinely useful device, which we never thought we'd say about a padlock.



SUPPLIER www.firebox.com



BACKPACK

RiutBag R10 / **£79** inc VAT

Another darling of Kickstarter, the RiutBag (pronounced, 'riot bag') aims to level up the security of the humble backpack. It simply moves all the zips to the bag's rear, meaning they're pressed safely against your back while you're wearing it, making them inaccessible to light-fingered sorts. It's ingeniously simple and effective, although getting into the backpack itself can be a fussy experience – we had to fully remove it each time – you can't simply unzip it while it's hanging off your shoulder, as you would with a conventional backpack.

Inside there are numerous pockets, including a padded area for a 15in laptop, and while the overall design is quite slim (meaning fat items such as DSLR cameras fit awkwardly) we found the ten-litre capacity more than adequate for normal everyday use.



SUPPLIER www.riut.co.uk



DRONE

Skeye Nano Camera / **£60** inc VAT

Despite only measuring 2cm² and weighing 14g, the Skeye Nano Camera Drone impressively packs a camera, Micro SD slot and battery into its tiny innards. Thoughtfully, it's also bundled with a 2GB Micro SD card and a USB card reader, making the £60 asking price look reasonable.

Not surprisingly, though, performance isn't great. Images from the camera are poor quality, and the battery only lasts 3–4 minutes. Its small size also makes it twitchy to fly, and we found ourselves recalibrating the link between the drone and the remote every time we crashed it (which was often). It might provide some fun for one afternoon, but it will quickly find itself gathering dust afterwards.



SUPPLIER www.firebox.co.uk





BLUETOOTH SPEAKER

JBL Xtreme / £250 inc VAT

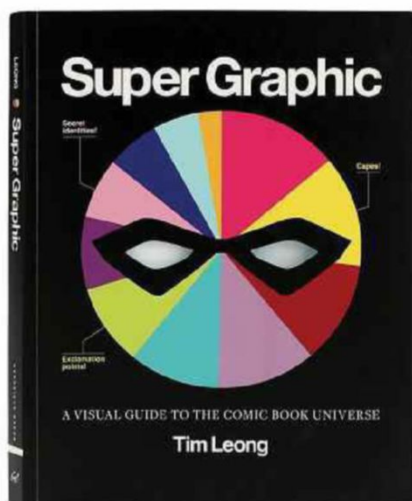
The JBL Xtreme kicks out one hell of a din, thanks in part to the large bass drivers mounted at each end. In fact, the bass is so powerful that it dominates music played through the speaker. The mix is still controlled enough to be pleasant, but it won't satisfy picky listeners.

Weighing over 2kg, the Xtreme is also right at the top end of what we'd call portable – it will be more at home in the garden than in a backpack. Also, we're growing used to seeing waterproof,

submergible Bluetooth speakers these days, so it's a little disappointing that, given its name, price and rugged looks, the JBL Xtreme is only rated as splashproof. Still, if you have the money, and you like your outdoor music with thumping bass, the JBL Xtreme makes a remarkable sound for its size.



SUPPLIER www.currys.co.uk



BOOK

Super Graphic / £11 inc VAT

Super Graphic is a beautifully presented guide to the comic book world, but anyone with an interest in graphic design or statistics will also get a kick out of the creative way author Tim Leong has put the book together. Each graph, table and chart has had a lot of love and time lavished on it, and it's nearly impossible to just flick through a few of them without getting hooked. A broad range of material is covered (from The Punisher to Scrooge McDuck) too, which may annoy dyed-in-the-wool purists, but makes the book accessible to nearly anyone.

Some pages are a little light on information, which makes us suspect Leong was stretching his source material to breaking point by the end, but at £11, Super Graphic is a great book for the money.



SUPPLIER www.amazon.co.uk



EXTERNAL BATTERY

TYLT Energie 6k / £50 inc VAT

The Energie 6k might look like a standard 6,000mAh external battery, albeit one with a built-in charging cable, but it has a trick up its sleeve – a flick-out, American, type-A plug adaptor on its rear. It's a sound idea, as it means it can entirely replace a normal wall charger as well as functioning as a battery, cutting down on the amount of clobber you need to carry (or remember) when travelling. The obvious drawback for us limeys is the need for an adaptor to use the 6k in the UK. TYLT bundles one with the unit, but using it feels clunky, as the adaptor is a bulky separate item, robbing the battery of its simple all-in-one premise. This drawback, in combination with the high price, mean the 6k is only worth considering if you spend a lot of time in the USA.



SUPPLIER www.amazon.co.uk

Seen something worthy of appearing in Custom Kit? Send your suggestions to paul_goodhead@dennis.co.uk

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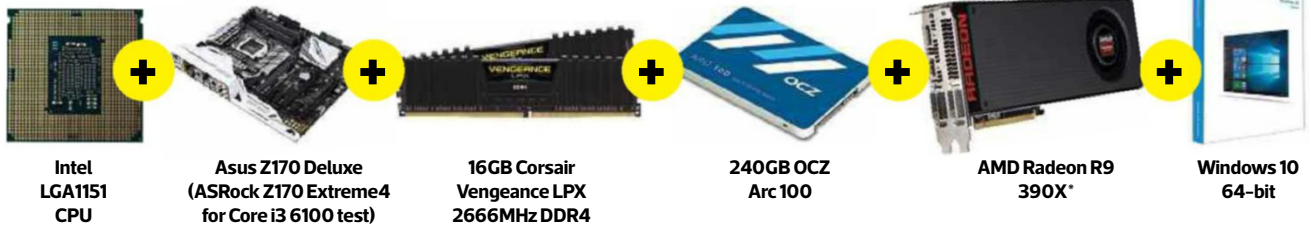
How we test

Thorough testing and research is the key to evaluating whether a product is worth buying, and deciding whether or not there's a better alternative

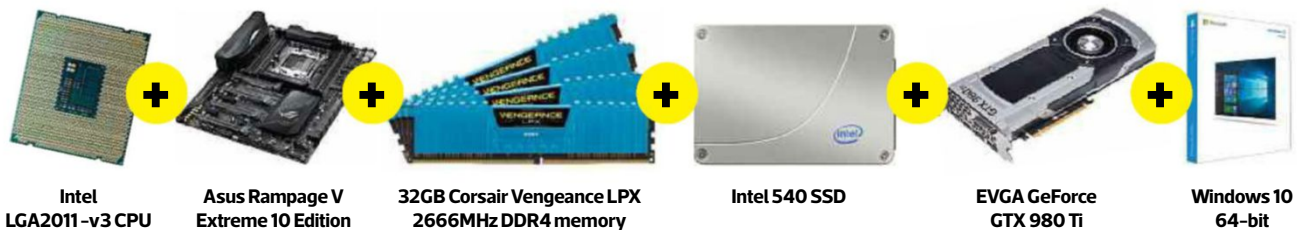
PROCESSORS

We judge CPUs on whether they offer sufficient speed for the price. Part of a CPU's speed score comes from how overclockable it is. Every type of CPU is tested in the same PC, so all results are directly comparable.

INTEL LGA1151



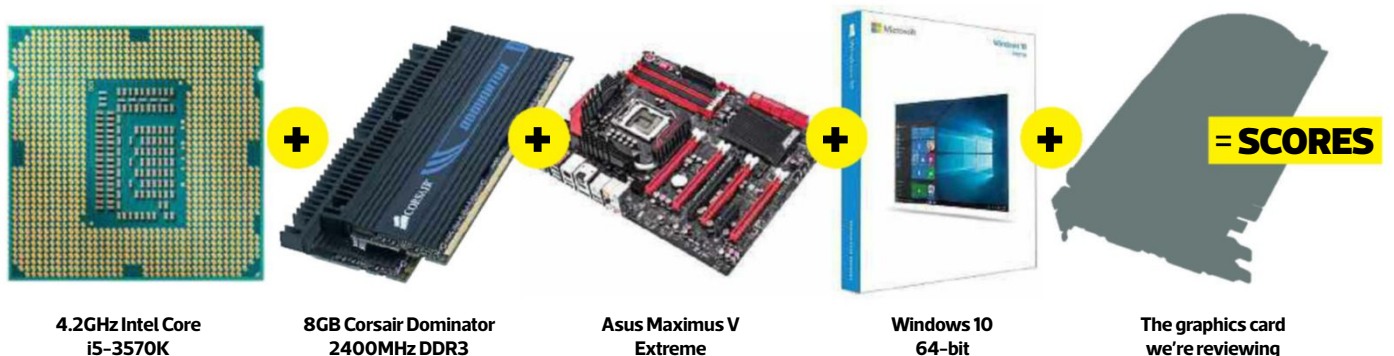
INTEL LGA2011-V3



TESTS: We use Custom PC RealBench 2015, Cinebench R11.5 and a variety of games. We also test the power draw of the test PC with the CPU installed. These tests reveal a broad range of performance characteristics, from image editing to gaming and video encoding to 3D rendering. We run all tests at stock speed and again when overclocked to its highest frequency.

GRAPHICS CARDS

Graphics cards are mainly evaluated on how fast they are for their price. However, we also consider the efficacy and quietness of the cooler. Every graphics card is tested in the same PC, so all results are directly comparable.



CUSTOM PC REALBENCH 2015

INTEL REFERENCE



AMD REFERENCE

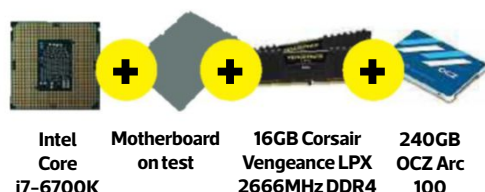


Our benchmark suite, co-developed with Asus, simulates how people really use PCs – a higher score is better. You can download them from www.asus.com/campaign/Realbench

MOTHERBOARDS

Motherboards are evaluated on everything from layout and features to overclockability and value for money. Every motherboard is tested with the same components, so all results are directly comparable.

INTEL LGA1151



AMD FM2+



INTEL LGA2011-V3



COMMON COMPONENTS



TESTS: We use Custom PC RealBench 2015 and Total War: Attila, and also test the speeds of the board's SATA and M.2 ports. We try to overclock every motherboard we review by testing for a maximum QPI, base clock or HTT as well as overclocking the CPU to its maximum air-cooled level. We run our tests at stock speed and with the CPU overclocked.

*Please note: We test AMD FM2+ motherboards using the on-board graphics, not the AMD Radeon R9 390X

The Awards



EXTREME ULTRA

Some products are gloriously over the top. These items of excellent overclock earn our Extreme Ultra award.



PREMIUM GRADE

Premium Grade products are utterly desirable – we'd eat nothing but beans until we could afford them.



PROFESSIONAL

Products worthy of the Professional award make you and your business appear even more awesome.



APPROVED

Approved products are those that do a great job for the money; they're the canny purchase for a great PC.



CUSTOM KIT

For those gadgets and gizmos that really impress us, or that we can't live without, there's the Custom Kit award.



TESTS: By using the fast PC detailed on the left, we can be sure that any limitations are due to the graphics card on test, rather than being CPU limited. We test GTA V, Doom, Crysis 3, Fallout 4 and The Witcher 3: Wild Hunt at their maximum detail settings, in their highest DirectX mode, at several resolutions. High-end cards should be able to sustain playable frame rates at 2,560 x 1,440, while 1,920 x 1,080 is more important for mid-range cards; we also test at 3,840 x 2,160 for 4K monitors, and try to overclock every graphics card we test to assess the performance impact.



Screen test

Ed Chester pits six 27in, 2,560 x 1,440 gaming panels against each other to see which FreeSync and G-sync models you should buy

Featured this issue

Acer Predator XB271HU/p45
Acer XF270HU/p46

Asus MG279Q/p47
Asus ROG Swift PG279Q/p48

BenQ XL2730Z/p50
Dell S2716DG/p52

Results graphs/p53

How we test

When testing a monitor, we first consider the design and build quality. We also check the range and quality of stand adjustments – height, rotation, tilt and pivot, so we also look at the range and quality of the movements.

Next, we assess the selection of video outputs, and look at extras such as ports, and speakers. We also consider the on-screen display (OSD), and the controls used to navigate it.

Then we move on to image quality, using both subjective and objective tests, the latter conducted with an X-Rite i1Display Pro colorimeter. First, we reset each display to its default settings, so we can assess its out-of-the-box performance. Nearly all monitors arrive with the brightness set too high for daily use, but that's an easy fix. Instead, we're concerned with whether the default colour modes and settings for contrast and sharpness are good enough.

Next, we tweak the more obvious settings to see if you can easily get your

display looking right without a colorimeter. Only then do we dive into the settings to set the display up as optimally as possible, continually testing it with a colorimeter along the way. Here, we set the monitor to a standard brightness of 120 nits, which is the normal setting we'd suggest for daily use.

We gauge the colour temperature – a measure of whether the colour balance is correct, which should be at the industry standard of 6500K. Any result within around 500K of this figure is acceptable; much below that number will look obviously yellow-tinged, while results above that figure will look too blue.

We also assess the colour gamut; the percentage of the standard sRGB and AdobeRGB colour palettes.

The former is the computing standard, while the latter is only really needed if you work in printing as a professional photographer or publisher. Any result above 90 per cent sRGB is decent, but the closer to 100 per cent the better.

Next is the delta E, which refers to the ability to pick out fine gradations in colour – the lower the number the better. Any result below 3 is decent, while the best 10-bit panels will get below 0.1. Viewing angles are also key, which is often where TN panels suffer. They look fine viewed head-on, but if you move around, or the display is really big, you'll see colour and contrast changes. IPS, PLS and other technologies largely don't suffer from these problems.

We also play plenty of games on each display, and assess how well the high-speed panels work – whether they look and feel as fast as claimed or if there's ghosting or other issues. Plus we engage and disengage adaptive sync (FreeSync or G-Sync) to see how well the tech eliminates tearing and stuttering.

We derive the scores from a combination of image quality – based on the subjective and objective tests, features and value. We consider adaptive sync a feature, rather than an image quality factor.

Acer Predator XB271HU / £549 inc VAT

SUPPLIER www.ebuyer.com

The XB271HU is Acer's flagship 27in high refresh rate gaming display, and it starts this shootout with a big bang. Like several of the monitors on test, its standout feature is its high-speed IPS panel. The Predator can blaze along at 165Hz, theoretically even surpassing most TN models, which max out at 144Hz.

What also really makes the Predator, and some of the other monitors on test, such a tempting proposition is its host of other must-have features. There's adaptive sync in the form of Nvidia G-Sync, so you can say goodbye to image tearing and stutter, assuming you own an Nvidia graphics card.

The stand is also fully adjustable, with 120mm of height adjustment, the option to turn the panel into a portrait orientation, plus tilt and rotation. The stand can also be removed so you can attach a third-party monitor stand, via the 100 x 100mm VESA mount.

Furthermore, the panel itself is a new so-called borderless model, where a part of the bezel sits below the display's front pane of plastic, effectively making the bezel disappear when the display is switched off. As a result, the whole monitor looks slim and sleek.

Overall, build quality is also excellent, although the slightly less garish Asus ROG Swift PG279Q (see p48) just has the edge as an overall design. Another area where the Acer trails the Asus is the OSD.

Navigation is slow and unintuitive, thanks to the control system just being a set of unmarked buttons along the bezel's front right edge.

What's more, both monitors suffer from a frequent limitation of G-Sync, which is the lack of connection options. You get just one DisplayPort and one HDMI port, so there's no room to plug in all your games consoles without resorting to an HDMI switcher. However, you do get a headphone jack, a pair of 2W speakers and a USB hub with four USB 3 ports (two on the back and two on the left edge).

As for image quality, the XB271HU is as fantastic as its spec sheet suggests. The advantage of the IPS panel is immediately clear. Viewing



Drop the brightness and you hardly need to make any other adjustments

angles are better than TN models, and as a result the image is far more even across the full area of the panel. TN panels have improved immensely in recent years, but the step up to IPS, or other competing technologies, is still clear.

What's more, the default configuration is by far the best on test. Almost every aspect of display quality is either best in class or up there with the best, with only the expected high brightness being a problem.

Drop the brightness and you hardly need to make any other adjustments to get a great image.

The 165Hz panel works flawlessly in games too, with none of the slight ghosting we've seen from some non-TN gaming panels. Combine it with G-Sync and you get a rock solid image that's smooth, tear-free and responds as quickly as your actions.

Conclusion

The Acer Predator XB271HU offers the holy trinity of a high refresh rate, an IPS panel and adaptive sync tech. Its image quality is great, and it has all the speed you need for gaming. The Asus ROG Swift PG279Q has a better OSD and superior stand, making it the better monitor of the two, but it's also much pricier. If you don't have the cash for the Asus, the Predator will also serve you well.

IMAGE 45/50 FEATURES 17/20 VALUE 26/30

VERDICT

A superb gaming monitor. You pay a premium for G-Sync but the image quality is great.

OVERALL SCORE
88%

SPECIFICATIONS

Screen size 27in
Resolution 2,560 x 1,440
Panel tech IPS, 165Hz
Inputs 1x DisplayPort, 1x HDMI 1.4
USB 4x USB 3 ports
Speakers Stereo 2W speakers
Power supply Internal
OSD control Buttons
Active sync tech G-Sync



Acer XF270HU / £379 inc VAT

SUPPLIER www.overclockers.co.uk

The Acer XF270HU at first appears to just be the FreeSync version of the XB271HU, with both monitors sporting high-speed IPS panels, fully adjustable stands and a form of adaptive sync tech. However, Acer has cut a few costs elsewhere on this screen, so the £170 price difference isn't just down to the cost of implementing G-Sync.

In terms of specs, the XB271HU's refresh rate goes to 165Hz while the XF270HU only goes to 144Hz, but that's a token difference that won't be noticeable in real use. Instead, the tangible differences come from the design and build quality. The XF270HU still offers a versatile adjustable stand and VESA mount option, but the movements aren't quite as smooth and the smaller, round base isn't quite as stable.

You also miss out on the low-profile bezels – they're not particular big and bulky on the XF270HU, but the difference is noticeable and the whole display doesn't have such a slim and modern look as the XB271HU. What it lacks in wow factor, though, the XF270HU makes up in features. Joining the IPS panel, FreeSync support and fully adjustable stand is a wealth of connection options. You still only get one DisplayPort connector, but it's joined by two HDMI sockets and a DVI-DL output. You also get a pair of 5W speakers and a 4-port USB 3 hub, with two ports on the underside and two on the left edge.

Like its G-Sync sibling, though, the XF270HU's OSD controls aren't ideal. Again, the buttons are unmarked and the way you move around the menus seldom feels intuitive. It isn't much of a problem, though, as the out-of-the-box performance is excellent. It can't quite match the XB271HU, but it's very close and beats the far more expensive Asus PG279Q in some aspects, both out of the box and when calibrated.

The main slight tweak that's needed is moving from the Warm colour setting to the User colour setting (leaving all three RGB channels on full), which moves the colour temperature from 6395K to 6562K. Otherwise, though, the only change needed to achieve a great image is to drop the brightness from its default of 282 nits to a more sensible 120 nits.

With those changes made, contrast, gamma, colour temperature and colour gamut coverage are all either up there with the best on test or very close to them, with



FreeSync works from 40Hz all the way up to 144Hz, dealing with tearing and stuttering

only the delta E score of 0.78 being a touch behind the two more expensive G-Sync models that drop below 0.6.

Firing up a game with FreeSync is great too. Performance is smooth and consistent, with the technology working from 40Hz all the way up to 144Hz, and dealing perfectly with both tearing and stutter – you'll need to make sure your graphics hardware is capable of staying above 40fps at the native resolution to keep FreeSync working though.

On the downside, the brightness uniformity is the worst on test, with a maximum drop of 7.35 per cent in the bottom-left corner, and an average variation of 4.2 per cent. However, those results are still well within the limits of what's noticeable in everyday use.

Conclusion

Acer has cut a few corners in terms of build quality on the XF270HU, but its wealth of

features, great image quality and fantastic gaming performance makes it a superb choice if you have a powerful AMD graphics setup. It's also a great display if you aren't bothered about active sync tech, as it's significantly cheaper than the G-Sync alternatives.

IMAGE 44/50 FEATURES 16/20 VALUE 27/30

VERDICT

A great image, plenty of features and competitive pricing – the XF270HU is ideal for AMD gamers.

OVERALL SCORE

87%

/ SPECIFICATIONS

Resolution 2,560 x 1,440

Panel tech IPS, 165Hz

Inputs 1x DisplayPort, 1x HDMI 2, 1x HDMI (MHL), 1x DVI-DL

USB 4 x USB 3 ports

Speakers Stereo 5W speakers, 3.5mm in/out

Power supply Internal

OSD control Buttons

Active sync tech FreeSync

Asus MG279Q / £455 inc VAT

SUPPLIER www.scan.co.uk

The Asus MG279Q is a cheaper FreeSync sibling to Asus' flagship G-Sync monitor, and it cuts a few corners to make up for the £210 price difference. Build quality is the main issue, with the MG279Q's frame feeling a little plasticky. The choice of a slightly greyer plastic than usual doesn't help either, with black monitors arguably looking more stylish, although that's really a matter of personal taste.

Although the stand is fully adjustable, the mechanisms are a little stiffer and less fluid than those of the PG279Q too. On the plus side, like all but one of the monitors on test, the stand comes apart with the touch of a button – no screws required – and there's a 100mm x 100mm VESA mount available underneath it, making for a versatile setup.

Low-profile bezels are out the window, though, with more conventional ones used instead. They're still narrow but stand proud so they don't look as stylish as low-profile ones. However, the MG279Q trumps the PG279Q when it comes to connection options. The MG279Q has one DisplayPort socket, one mini DisplayPort connector and two HDMI outputs, compared to just one DisplayPort socket and one HDMI port on the PG279Q.

You also get a two-port USB 3 hub, a pair of perfectly decent stereo 2W speakers and a 3.5mm headphone socket. Meanwhile, the rear-mounted OSD controls are the best in the business. There's a little joystick that's used to navigate through the menus, and it makes using the menu system so much easier than any other system we've seen.

However, the options themselves aren't the best. Most of the game modes are superfluous and the default image quality settings are atrocious. Out of the box, it's set to a Racing colour mode that's overly bright with a colour temperature that's way off target. It's by far the worst out-of-the-box experience of the monitors in this test.

What's more, selecting the often reliable sRGB colour mode is no good either, as it drops the contrast ratio to just 666:1.

The Scenery mode offers the best balance, although it isn't perfect, and getting the colour temperature in check required manually adjusting the colour balance from 100x100x100 (RxBxG) all the way down to 100x95x91. Once all those tweaks have been made, the screen's performance is okay. Its delta E isn't great – in fact, it rises from 0.58 in



Running a game at 90Hz is a pleasant step up from 60Hz in terms of smoothness

the default mode to 2.54 once all our tweaks were made, but it's the best compromise we could find. It's a shame, as the MG279Q clearly has a reasonably capable panel that trumps TN-equipped models, thanks to inherently good viewing angles, but setting it up is frustrating.

Meanwhile, the FreeSync support only works between 35–90Hz – the maximum is lower than that of the Acer XF270HU, but on the plus side, you don't need to ask so much from your graphics hardware to get FreeSync working – it just needs to stay above 35fps. FreeSync works great too.

Even just running a game at 90Hz is a pleasant step up from 60Hz in terms of smoothness of gameplay, and the lack of tearing or stuttering is clear to see.

Conclusion

The MG279Q might not have the wide FreeSync range of the Acer XF270HU, but it kicks in at a lower frame rate, making it less

demanding of graphics hardware. In terms of specs, it's a good monitor. In practice, however, the build quality is disappointing for the money, and the image quality is massively compromised by a poor selection of modes in the OSD. There's still decent image quality to be found if you take the time to tweak it, but even then, you can find a better monitor for less money.

IMAGE 39/50 FEATURES 17/20 VALUE 25/30

VERDICT

Lots of connections and FreeSync support, but let down by disappointing image quality options.

OVERALL SCORE
81%

/ SPECIFICATIONS

Screen size 27in

Resolution 2,560 x 1,440

Panel tech IPS, 144Hz

Inputs 1x DisplayPort, 1x mini DisplayPort, 2x HDMI 1.4

USB 2x USB 3 ports

Speakers Stereo 2W speakers, 3.5mm out

Power supply Internal

OSD control Joystick

Adaptive sync tech FreeSync

Asus ROG Swift PG279Q / £669 inc VAT

SUPPLIER www.ebuyer.com

As the most expensive monitor on test this month, there are big expectations of the Asus ROG Swift PG279Q, and thankfully it delivers. Like Acer's XB271HU, it's the combination of a 165Hz IPS panel with G-Sync that mainly drives up the cost, but Asus has also cranked up the build quality and design. The ultra-slim, low-profile bezels give the whole unit instant desk appeal. The bezels aren't quite as narrow as those of the Acer, but the Asus still looks slim and sleek.

Then there's the stand. Built from high quality, sturdy plastic, its solidity is unmatched by any other monitor on test this month. What's more, it lights up. The circle surrounding the area where the stand enters the base glows red when the monitor is switched on, as does the Asus Republic of Gamers logo in the front right corner. It's a totally frivolous feature but it adds to the sense of premium quality.

Thanks to that hefty stand, adjusting the height of the monitor, or twisting it into portrait mode, is smooth and easy. However, while it has a VESA mount, the PG279Q is the only monitor on test that requires a screwdriver to remove the stand.

As with other G-Sync monitors, the big compromise is connections, with just one DisplayPort socket and one HDMI port included. Also, Asus has tucked up all the connections in the v-shaped section at the back, which helps to guide the cables to the centre, where they can be run through the cable-tidying hole in the stand, but it makes insertion and removal more awkward.

We have no other complaints though. Asus' joystick-based OSD controls are the best in class. What's more, the menus are lightning-fast too, making it a breeze to quickly change a setting or input.

Image quality is also fantastic right out of the box. Where the MG279Q was overly sharp with bad colour accuracy, the PG279Q nails almost every test right off the bat. Of course, brightness is too high at 318 nits (and that's only with the brightness set to 80/100), but otherwise you could easily run the PG279Q without any tweaking at all. It also can't quite match the Acer XB271HU for colour accuracy, but the contrast figure of 1,324:1 is the best of the bunch.

Plus, compared with TN monitors, you get the inherent upgrade in image quality from the IPS panel, so you get a far more stable



Image quality is fantastic right out of the box – the PG279Q nails almost every test

image where colours and contrast don't shift and change as you move your head slightly.

Go to the effort of tweaking this display and it doesn't disappoint. As with the XB271HU, the PG279Q's image quality is basically as good as you can get, without specifically seeking out a photography-grade monitor with a 10-bit panel. Then there's G-Sync and that 165Hz refresh rate, which combine to create a stunning gaming experience.

Games are handled lightning with no hint of ghosting, lag, tearing or stutter. It's simply a fantastic gaming experience that has to be seen to be believed.

Conclusion

Asus may charge a hefty premium for the ROG Swift PG279Q, but it justifies its premium by being the best gaming monitor we've reviewed. Image quality is fantastic, the

gaming experience is second to none and the build quality and design are class-leading. It's a toss-up between the PG279Q and the Acer XB271HU for the overall crown, but while the Acer is cheaper, the Asus' design and OSD controls just pull it ahead.

IMAGE 47/50 FEATURES 18/20 VALUE 24/30

VERDICT

Excellent image quality, a great gaming experience and fantastic build quality, although you pay for it.

OVERALL SCORE
89%

/ SPECIFICATIONS

Screen size 27in

Resolution 2,560 x 1,440

Panel tech IPS, 165Hz

Inputs 1x DisplayPort, 1x HDMI

USB 2x USB 3 ports

Speakers Stereo 2W speakers, 3.5mm in/out

Power supply External

OSD control Joystick

Active sync tech G-Sync

INDEPENDENT AND UNOFFICIAL GUIDE

MINECRAFT SECRETS & CHEATS



Available Now!

BenQ XL2730Z / £431 inc VAT

SUPPLIER: www.scan.co.uk

BenQ's XL2730Z may not have an IPS panel, but it has plenty of features. There's a wired remote control for navigating the OSD, with a central scroll wheel and five surrounding buttons that make navigating the menus incredibly quick and easy. If you ever lose the remote, you can also fall back onto the conventional buttons along the right bezel.

Another really useful feature is the pop-out headphone stand that emerges from the left side. It may sound like a token extra but it's immensely useful if you use your headphones a lot, and it's complemented by the headphone and microphone 3.5mm jacks on the left edge, plus a couple of USB 3 ports. This positioning, plus the addition of that microphone port, is again a huge convenience boost. Connection options are good too, including one DisplayPort socket, two HDMI ports, one DVI-D connector and even an old-school VGA input.

Another area where BenQ has really gone to town is the stand. It features all the usual height, rotate, swivel and tilt options, but each option has an indicator or dial associated with it, so you can find your preferred setup, make a note of each number and easily find your preferred settings again if you move it.

The screen's design and build quality isn't quite on the same level as the Acer XB271HU and Asus PG279Q, but sits somewhere between those displays and their cheaper siblings. It uses good materials and offers smooth, well-crafted stand adjustments, but there's no borderless panel or other premium materials on show.

Not surprisingly, firing up the BenQ XL2730Z immediately shows the downsides of having a TN panel, with the telltale shifting, shimmering effect as you move your head around, due to the inherently narrower viewing angles. In every other regard, though, the XL2730Z is a very capable display.

Out of the box, its colour temperature isn't exactly stellar, at 7310K, but the delta E is a decent 1.64 and the contrast is a plentiful 991:1. Switching to the manual colour mode with all the colour settings at 100 moved the colour temperature to 6211K though. Then, dialling back the brightness to 120 nits and running a full calibration brought the delta E to 1.73, along with a boost in contrast to 1139:1, while sRGB coverage hit 98.1 per cent and gamma stayed near enough, at 2.1. In short, the XL2730Z is a perfectly capable monitor in



It uses good materials and offers smooth, well-crafted stand adjustments

most regards, so it really comes down to whether you find the viewing angle issues of TN panels to be a problem.

For gaming, this monitor offers a 144Hz refresh rate and FreeSync at 40-144Hz, so it provides a rock-solid image at lightning-fast speeds, as long as you have an AMD GPU that's powerful enough to stay above 40fps. There's also a blur-reduction technology that uses a form of black frame insertion to reduce the appearance of motion blur. However, it doesn't work with FreeSync enabled and it massively reduces brightness, so it isn't a feature we recommend.

Conclusion

The BenQ XL2730Z offers great gaming features and, with the exception of the TN panel's viewing angles, delivers solid image quality. The viewing angles are a problem at this price, though, now that rivals equipped

with IPS panels no longer demand a huge premium. If your budget won't stretch beyond £431, then the BenQ is a decent monitor, but you'll be rewarded if you can find the extra cash for an IPS display.

IMAGE 37/50 FEATURES 19/20 VALUE 22/30

VERDICT

Versatile and feature-packed, but the TN panel's viewing angles are a letdown at this price.

OVERALL SCORE
78%

/SPECIFICATIONS

Screen size 27in

Resolution 2,560 x 1,440

Panel tech 144Hz TN

Inputs 1x DisplayPort, 1x HDMI, 1x DVI-D, 1x VGA

USB 2 x USB 3 ports

Speakers Stereo speakers, 3.5mm in/out

Power supply Internal

OSD control Buttons and wired remote

Active sync tech FreeSync

Extras Headphone stand

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Dell S2716DG / £420 inc VAT

SUPPLIER: www.overclockers.co.uk

The S2716DG represents Dell's first foray into gaming displays with active sync technology. You'd be forgiven for looking right past it in a store, as there are none of the telltale gamer giveaways when it comes to design. It's as sleek and stylish, yet business-like, as we would expect from Dell.

The only hint that the S2716DG isn't meant for office use is the glossy plastic back, where we'd normally see a more mundane matt finish, although the latter wouldn't show dust as easily either. Otherwise, though, it's the best looking monitor on test. Its gunmetal base and black frame look wonderfully understated, and the borderless panel make those bezels blend away to nothing when there's no power.

Meanwhile, the practical stand offers the full range of adjustments. The actions aren't quite as smooth as with some stands on test, but you can just about move it in all directions one-handed. As with other G-Sync monitors, though, the S2716DG is let down by a lack of connections. You get one HDMI port, which is more than some G-Sync displays, but otherwise, it's just that solitary DisplayPort socket again.

Thankfully, it's better equipped elsewhere, with a 4-port USB 3 hub split between two ports on the back and two on the left edge. You'll also find a headphone jack on the left, although there are no internal speakers. Dell's eye for design continues with the OSD buttons, which are tidily hidden on the underside of the right edge.

However, there's no indication of their whereabouts, so you just have to fumble about until you press one of them – hopefully not the power button – and activate the OSD, which then aligns with the buttons.

The OSD itself is very basic, with just four colour options and no game modes or other fancy features. In fact, it's almost too basic – there isn't even an sRGB mode, for example. However, thanks to those simple colour settings being pretty good, there's really no need to worry. Out of the box, the monitor delivers a colour temperature of 6814K, gamma of 1.9 and a delta E of 1.51. It isn't perfect, but it's good enough.

Simply dropping the brightness to a more sensible 120 nits and opting for the User colour mode (all colours on full) pushed the colour temperature down to 6601K, while gamma improved to 2 as well.



Gaming is great fun with the combination of a 144Hz refresh rate and G-Sync support

Running a full calibration was all that was required to get near spot-on colour temperature, dropping the blue channel from 100 to 99. At this setting it delivered healthy results across the board. It isn't going to be suitable for imaging enthusiasts, but it's fine for everyday use for most people.

There are just two problems. First, it's a TN panel, so the usual rules apply for viewing angles not being as good as those of an IPS panel. Secondly, contrast is below par.

At best, we measured 872:1, which is okay, but once calibrated it dropped to 673:1. This result isn't awful, but it the image looks more washed out than on higher-contrast models. Nonetheless, gaming on this monitor is great fun with the combination of a 144Hz refresh rate and G-Sync support.

Conclusion

Dell's S2716DG is the best-looking monitor on test, and it has a sensible balance of features.

However, it's now pricey compared with similarly equipped IPS models that have better overall image quality, while its low contrast puts it behind other TN-based displays. If you're on a tight budget and Nvidia gaming is your top priority, then it's a decent screen, but we'd advise saving a little more money for an IPS panel instead.

IMAGE 35/50 FEATURES 17/20 VALUE 23/30

VERDICT

A stylish display with G-Sync, but it's let down by poor contrast and a slightly high price.

OVERALL SCORE
75%

/ SPECIFICATIONS

Screen size 27in

Resolution 2,560 x 1,440

Panel tech TN

Inputs 1x DisplayPort 1.2, 1x HDMI 1.4

USB 4x USB 3 ports

Speakers No, 3.5mm headphone out

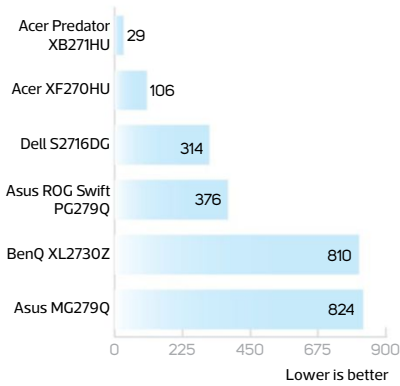
Power supply Internal

OSD control Buttons

Active sync tech G-Sync

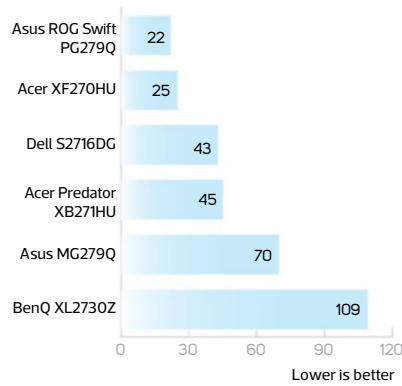
UNCALIBRATED COLOUR TEMPERATURE (KELVIN)

Deviation from ideal result (6500K)



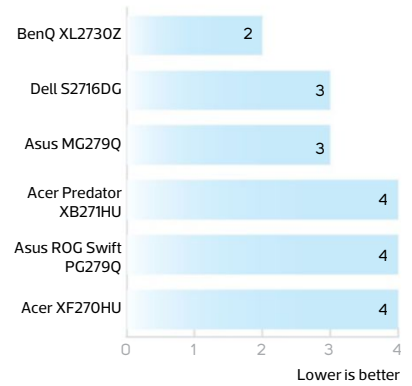
CALIBRATED COLOUR TEMPERATURE (KELVIN)

Deviation from ideal result (6500K)



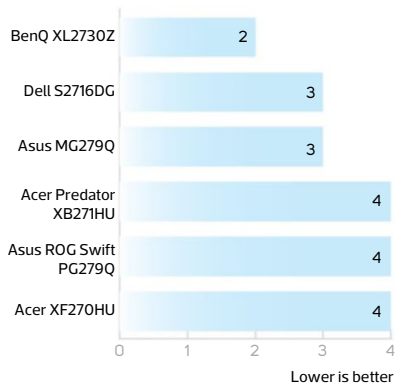
UNCALIBRATED BRIGHTNESS UNIFORMITY (AVERAGE PER CENT)

Mean deviation



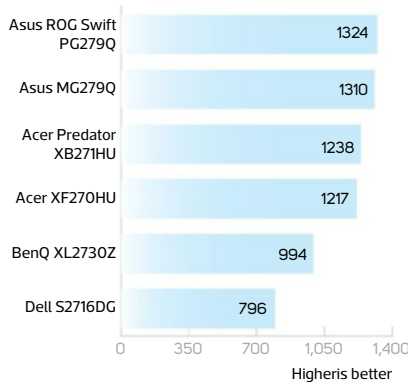
CALIBRATED BRIGHTNESS UNIFORMITY (AVERAGE PER CENT)

Mean deviation



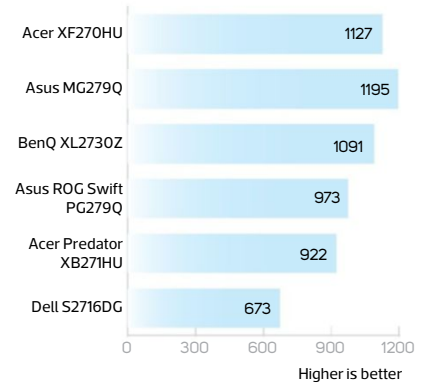
UNCALIBRATED CONTRAST RATIO

Ratio of white-to-black luminance



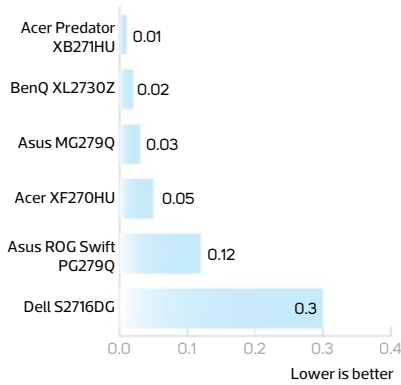
CALIBRATED CONTRAST RATIO

Ratio of white-to-black luminance



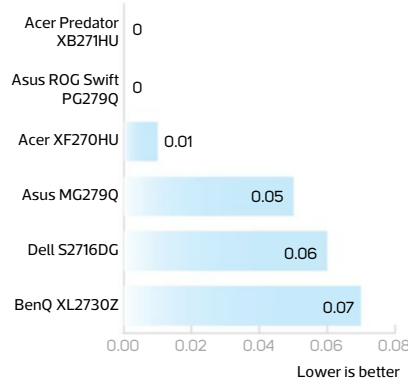
UNCALIBRATED AVERAGE GAMMA

Deviation from ideal result (2.2)



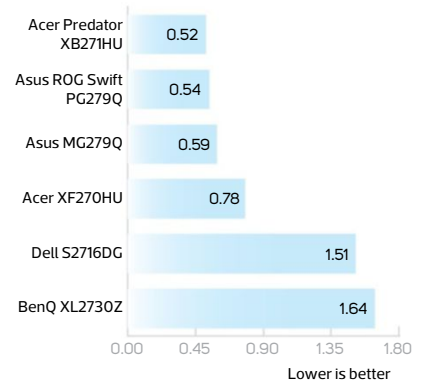
CALIBRATED AVERAGE GAMMA

Deviation from ideal result (2.2)



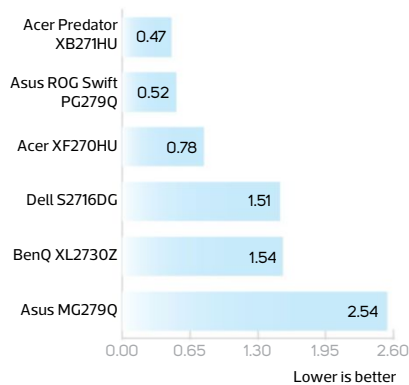
UNCALIBRATED COLOUR ACCURACY

Average delta E 2000



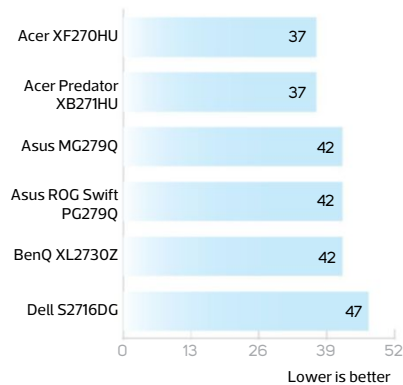
CALIBRATED COLOUR ACCURACY

Average delta E 2000



POWER CONSUMPTION (WATTS)

White screen at max brightness





LABS TEST

Fan-tastic

Chief spin doctor Antony Leather tests eight low-noise 120mm fans at different voltages to find the kings of airflow and quiet operation

Featured this issue

Aerocool DS Edition / p55

Be Quiet! Shadow Wings / p55

BitFenix Spectre Pro / p56

Corsair SP120 Quiet Edition / p56

Noctua NF-F12 / p57

Noiseblocker BlackSilent XL-1 / p57

SilverStone SST-AP122 Air

Penetrator / p58

Thermaltake Pure S 12 LED / p58

Results graphs / p60

How we test

To test airflow performance we used a digital anemometer that can record air speed down to 0.1m/sec. It's placed behind a large 120mm Monsta radiator, with both objects fixed in position for repeated testing. The fan is attached to the front of the radiator and we measure the speed of air passing through it. This reading is a good indication of static pressure and how well the fan will perform on radiators and heatsinks, as well as when it's pushing air through your case – exactly the types of scenarios you'll encounter.

To measure noise, we used a digital sound meter. To eliminate the effect of ambient noise and to be able to measure fans that have hard-to-measure sub-30dB(A) noise levels, we simply moved the sound meter to within 2in of the fan so that it appears louder. As a result, these figures

aren't comparable with the sound levels stated on other fans, or the typical measurements for traffic or jumbo jets, which are usually measured from much further away. However, our results are directly comparable between fans we test, so we can identify the most important aspect – the quietest and noisiest fans, and rank them in order of quietness.

We also factored a sound quality rating into the scores, based on whether the fan noise is annoying. For example, one fan may be quieter than another, but suffer from mechanical noise, which can be much more irritating, even if the fan is quieter as a whole. We tested each fan at 5V, 7V and 12V using a Lampron CW611 fan controller, confirming the voltage with a multimeter and also recording the indicated speed at each voltage.

To gauge each fan's performance in terms of noise versus airflow, we include graphs that show the noise divided by the airflow, represented in the Performance scores. The lower this figure, the more airflow you get for the same noise, irrespective of speed. The decibel scale isn't linear, though, with sound pressure multiplying by 100 times every 10dBA. To the human ear, however, sound appears to double every 10dB(A), so we include a calculation to take the human factor into account. In short, a fan that reads 60dB(A), will be scored as if it's twice as loud as a fan that reads 50dB(A). This Labs test only features quiet fans (800rpm to 1,500rpm), and we list each fan's startup voltage in case you want your motherboard's automatic fan controller to turn off the fans when your PC is idle.

Aerocool DS Edition / £10 inc VAT

SUPPLIER www.overclockers.co.uk

One of the racier-looking fans on test, Aerocool's DS Edition sports blade strips that look great when they're spinning, and four LEDs shine into the blades too. The DS Edition also includes anti-vibration mounting pins, a 3-pin to 4-pin Molex adaptor and a 20cm 7V speed reduction cable – not bad for a tenner.

There were no funny sounds before the blades started spinning, but while Aerocool states a startup voltage of 3V, we measured it at 5V. While the fan was the loudest on test at 5V, it managed 1m/sec of airflow at 54dB(A), showing good efficiency, although the Noiseblocker BlackSilent XL-1 (see p57) produced the same airflow at just 51dB(A) at 7V. Meanwhile, sound quality was average,

and the efficiency didn't last at 12V, where it managed airflow of 1.5m/sec and was very loud compared with most of the other fans on test, pushing out 67dB(A). Corsair's SP120 Quiet Edition (see p56) managed better airflow at 1.6m/sec, making for considerably less noise at just 63dB(A).

The Aerocool DS Edition is a mixed bag, but it has great looks, a decent accessories bundle and good 5V performance. It's a shame Aerocool didn't include a 5V adaptor instead of a 7V one, but if you can knock down the voltage to 5V, it's one of the better fans on test and the best-looking too. If you intend to run it at 12V, though, there are more efficient, quieter options, albeit without the dashing good looks.



VERDICT

Great-looking, loads of accessories and good low voltage performance, but other fans are better at higher voltages.

SPECIFICATIONS

Max speed 1,200rpm
Stated noise 16dB(A)
PWM No
LEDs Yes
Extras Braided cable, 3-pin to 4-pin Molex adaptor, anti-vibration mounting pins, 20cm 7V extension cable

12V		
PERFORMANCE	SOUND QUALITY	OVERALL SCORE
47/60	14/20	
FEATURES	VALUE	
8/10	5/10	74%

5V		
PERFORMANCE	SOUND QUALITY	OVERALL SCORE
54/60	14/20	
FEATURES	VALUE	
8/10	5/10	81%

Be Quiet! Shadow Wings / £11 inc VAT

SUPPLIER www.overclockers.co.uk

The Be Quiet! nifty-looking Shadow Wings series of fans comes in a range of speeds, with either PWM or 3-pin power connections, and this test sample's maximum speed of just 800rpm makes it the slowest fan on test. There's a handy 7V adaptor in the box, but it only works if you connect it to a 4-pin Molex power connector. You also get anti-vibration push-pin mounts that secure to each of the fan's four rubber mounts, while the all-black blades sport grooves that Be Quiet! claims can focus airflow.

The claimed startup voltage was spot on, with the blades beginning to turn at 5V. At this voltage, its speed was under 500rpm, though, and its airflow of 0.2m/sec barely

registered on our airflow meter. It was completely inaudible from more than 6in away, with no discernible bearing noise at all. At 12V, the fan finally started to make some noise and the sound quality was superb, with a low thrum and gentle push of air that vanished once you moved more than 12in away. However, the Noiseblocker BlackSilent XL-1 was just as quiet at both voltages and managed better airflow too.

And that's the main problem for the Shadow Wings. While it has fantastic sound quality and near-silent operation at 5V, Noiseblocker's BlackSilent XL-1 offers better performance across the voltage range and is even quieter at 5V, plus it has a lower startup voltage and dishes out more air at 12V.



VERDICT

Superb sound quality and inaudible operation at 5V, but outperformed by Noiseblocker's cheaper BlackSilent XL-1.

SPECIFICATIONS

Max speed 800rpm
Stated noise 9.8dB(A)
PWM No
LEDs No
Extras Anti-vibration mounting pins, 3-pin to 4-pin Molex 7V adaptor

12V		
PERFORMANCE	SOUND QUALITY	OVERALL SCORE
50/60	19/20	
FEATURES	VALUE	
7/10	5/10	81%

5V		
PERFORMANCE	SOUND QUALITY	OVERALL SCORE
31/60	19/20	
FEATURES	VALUE	
7/10	3/10	60%

BitFenix Spectre Pro / £11 incVAT

SUPPLIER www.overclockers.co.uk

The Spectre Pro is one of BitFenix's premium 120mm models and it comes in both 3-pin and 4-pin PWM versions, with a range of colours. Our model is also illuminated with attractive white LEDs, which can be switched on/off using a 2-pin extension cable that can be hooked up to a lighting controller. Alternatively, you can just disconnect the LEDs if you prefer them off. You also get anti-vibration mounting pins and a 4-pin PWM to 4-pin Molex adaptor in the Spectre Pro's box.

Meanwhile, the frame of the fan is made up of two parts, which BitFenix claims will dampen vibration, while its reinforced fan blades help to prevent warping at high speeds and are claimed to focus airflow too. As we've

found several times this month, the startup voltage of 3.5V was much lower than the stated 5V. There was no noise at all until the fan blades started spinning either, but when they did spin, the Spectre Pro exhibited a slight electrical hum as well as clicking from the fluid dynamic bearing, although these noises weren't too intrusive.

However, the airflow of 0.8m/sec was matched by the SilverStone SST-AP122 Air Penetrator and at a lower noise level too. This situation was worse at 12V where the Spectre Pro was the noisiest fan on test, yet had similar or lower airflow than four other fans, with the Corsair SP120 Quiet Edition being considerably quieter and managing 0.1m/sec more airflow.



Sadly, while the Spectre Pro has a solid feature set and good looks, its efficiency isn't great. The SP120 is better across the range for just £2 more, and the cheaper Thermaltake Pure S 12 is better at 12V and costs £3 less.

VERDICT

Good-looking and lots of features, but let down by poor efficiency across the board.

/SPECIFICATIONS

Max speed 1,200rpm

Stated noise 19dB(A)

PWM No

LEDs Yes

Extras Anti-vibration mounting pins, 4-pin PWM to 4-pin Molex adaptor

12V

PERFORMANCE	SOUND QUALITY	OVERALL SCORE
43/60	15/20	68%
FEATURES	VALUE	
6/10	4/10	

5V

PERFORMANCE	SOUND QUALITY	OVERALL SCORE
53/60	15/20	78%
FEATURES	VALUE	
6/10	4/10	

Corsair SP120 Quiet Edition / £13 incVAT

SUPPLIER www.scan.co.uk

Corsair's SP (static pressure) series is designed to perform well with heatsinks and radiators. They're popular with water-cooling enthusiasts as a result, but while they've dropped in price recently, they still cost £13 a pop. Our sample offered PWM control and also sported three replaceable rings in blue, white and red. There are no LEDs or other extras, although it has built-in rubber anti-vibration mounts.

The fan itself has seven fairly wide blades and uses a hydraulic bearing. It comes in a few flavours too, from a monstrous 2,350rpm version to the Quiet Edition here, which maxes out at 1,450rpm. It's still one of the most powerful fans on test, though, and the balance of airflow and noise is brilliant. Efficiency was

fantastic across the board, especially at 5V and 7V, as was sound quality. At 12V it lost the lead to the Noiseblocker and Thermaltake fans, but it was only a short distance behind.

The only niggle is a bit of electronic murmuring just before it reaches its 2.5V startup voltage. As such, this fan isn't ideal for use with hardware that can switch it off in cool conditions, as powering it up again will likely see it making this noise. Otherwise, though, the SP120 Quiet Edition lives up to its reputation and is a fantastic all-rounder that's clearly adept at dealing with radiators and heatsinks. The only fly in the ointment is electronic noise just before the fan starts spinning, but at 2.5V and above, it's one of the best fans around.



VERDICT

A top-notch fan at 5V and 7V, and not bad at full speed either. Just don't run it below its startup voltage.

/SPECIFICATIONS

Max speed 1,450rpm

Stated noise 23dB(A)

PWM Yes

LEDs No

Extras Red, blue and white fan rings

12V

PERFORMANCE	SOUND QUALITY	OVERALL SCORE
55/60	17/20	82%
FEATURES	VALUE	
6/10	4/10	

5V

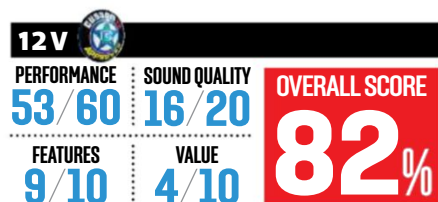
PERFORMANCE	SOUND QUALITY	OVERALL SCORE
57/60	17/20	85%
FEATURES	VALUE	
6/10	5/10	

Noctua NF-F12 / £14 incVAT

SUPPLIER www.ebuyer.com

Noctua's NF-F12 is the fastest and most expensive fan on test, but it has loads of accessories. There's a fan-speed reduction cable that cuts the speed from 1,500rpm to 1,200rpm, a Y-splitter cable that enables you to power two fans from a single 3-pin or 4-pin header, plus anti-vibration pins and an extension cable.

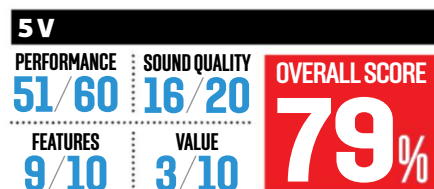
There's some serious design work behind the NF-F12, with varying angles between the rear guide vanes, which Noctua says will spread noise over a wider, more agreeable spectrum. There are also vortex notches that perform a similar task, while reducing turbulence and noise. Noctua uses its own oil-pressure bearing in the seven-bladed NF-F12, which also sports a PWM connector.



We found the NF-F12 started spinning at 5V, which isn't surprising for a 1,500rpm fan. However, like the Corsair SP120, it also produced some fairly significant electronic noise before it powered up, so it isn't ideal if your motherboard or fan controller is set to switch it off under low loads.

Performance-wise, the Corsair SP120 Quiet Edition outperformed it at 5V in terms of both noise and airflow. At 12V, though, it posted the highest airflow on test, with lower noise than three other fans on test, and it also dished out 0.2m/sec more airflow than the SP12, although with a little more noise. Thankfully, the sound quality was fine.

The NF-F12 doesn't quite live up to expectations at lower voltages, but it offers



solid 12V airflow performance. There are cheaper, slightly better options from Thermaltake and Noiseblocker, but they're devoid of the NF-F12's useful accessories.

VERDICT

An excellent fan at 12V with useful accessories, but it has stiff competition from cheaper fans.

SPECIFICATIONS

Max speed 1,500rpm
Stated noise 22dB(A)
PWM Yes
LEDs No
Extras 30cm 4-pin extension cable, 4-pin Y-splitter adaptor, low-noise adaptor, anti-vibration mounting pins

Noiseblocker BlackSilent XL-1 / £6 incVAT

SUPPLIER www.overclockers.co.uk

Noiseblocker's BlackSilent XL-1 spins at 1,000rpm, and has seven attractive glossy blue blades, along with a sleeve bearing. It also includes four rubber anti-vibration mounting pins. Noiseblocker claims its Bayer Makrolon rotor sports anti-dust technology too, although we couldn't put it through its paces for long enough to confirm its effectiveness.

Noiseblocker claims a 5V startup voltage, but our sample was spinning happily from 4V, where it was inaudible too. You can hear some slight bearing noise at 5V, but the sound quality is generally excellent. It's also quietest fan on test at this voltage, at just 43dB(A), while managing to shift more air than the Be Quiet! and Thermaltake fans, which produced

noise ratings of 44dB(A) and 45dB(A) respectively at close range.

It maintained its efficiency at 12V too, where it managed airflow of 1.3m/sec at a noise rating of 59dB(A), while the Be Quiet! only managed 1m/sec at the same noise level. Only the Thermaltake beat it at this voltage, managing the same airflow with a noise rating of just 58dB(A).

The Noiseblocker BlackSilent XL-1 is quiet, efficient and very reasonably priced. Its inaudible startup, super-quiet low-voltage operation and superb 12V efficiency makes it a great low-noise fan if you don't need the SP120's extra power, or the adaptors and accessories that come with other fans, such as the Noctua NF-F12.

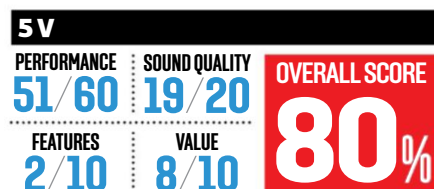
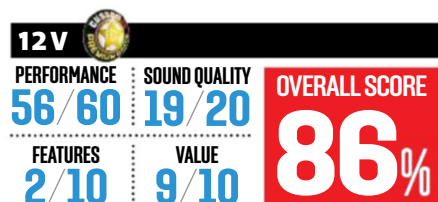


VERDICT

A low-price, quiet fan that starts up quietly and maintains good efficiency across the voltage range.

SPECIFICATIONS

Max speed 1,000rpm
Stated noise 13dB(A)
PWM No
LEDs No
Extras Braided 50cm cable, anti-vibration mounting pins



SilverStone SST-AP122 Air Penetrator / **£5** inc VATSUPPLIER www.scan.co.uk

SilverStone's 120mm AP122 costs just £5 – less than half the price of many other fans on test. It has an impressive total of nine blades crammed into a basic plastic frame, but it doesn't include any other parts except mounting screws.

The Air Penetrator grille at the rear is designed to channel the exhaust air in a straighter path than usual, which SilverStone claims will promote high pressure – ideal for use with heatsinks and radiators. The AP122 uses a sleeve bearing and has a stated maximum speed of 1,200rpm, putting it in the faster tier of fans on test.

SilverStone quotes a 9V startup voltage, but we found it started spinning at 5V. There was a hint of bearing noise, and Corsair's

SP120 was more pleasant-sounding, but it didn't suffer from any pre-start squealing and its efficiency rating almost matched the SP120 for airflow and noise. Driving up to 12V saw the noise become louder than the SP120, and with similar airflow.

If you tune down the SST-AP122 Air Penetrator to 5V, it maintains a respectable balance of airflow and noise for less than half the price of Corsair's SP120. However, the sound quality isn't spectacular and the SilverStone becomes less efficient with more voltage. At just £5, though, if you need to kit out your case or radiators with multiple powerful, quiet fans at a low voltage, it's an excellent option that could save you a fair wad of cash.

**VERDICT**

A great budget fan with quiet startup and excellent low-voltage efficiency, but it doesn't fare as well at 12V.

/SPECIFICATIONS

Max speed 1,200rpm
Stated noise 19.7dB(A)
PWM No
LEDs No
Extras None

12V		
PERFORMANCE	SOUND QUALITY	OVERALL SCORE
49/60	13/20	
FEATURES	VALUE	
2/10	9/10	73%

5V		
PERFORMANCE	SOUND QUALITY	OVERALL SCORE
56/60	14/20	
FEATURES	VALUE	
2/10	10/10	82%

Thermaltake Pure S 12 LED / **£9** inc VATSUPPLIER www.amazon.co.uk

The Pure S 12 LED has no fancy fan blade tech – just a seven-blade design and a standard sleeve bearing. It sports blue LEDs, but there are no accessories except mounting screws. Its plain exterior hides some serious power though.

Despite Thermaltake stating a startup voltage of 9V, the fan started spinning at just 2V – the lowest result on test. It was silent when starting up too, with no clicking or jerking. It barely shifted any air, though, even at 5V, where the noise measured just 45dB(A) at close range. It was inaudible more than 12in away, but its airflow measured just 0.2m/sec – the joint lowest result on test, at 483rpm.

However, the situation was reversed when we ramped up the voltage to 12V. Not only

was the sound smooth and click-free, producing just a low thrum with no high-pitched whining, but its noise-to-airflow ratio pipped every other fan on test at this voltage. It only managed this feat at 12V though – even at 7V, it was still bettered by Corsair and Noiseblocker's entries.

The Thermaltake Pure S 12 LED offers a fantastic balance of noise and airflow at full speed, although it shifts less air than Noctua or Corsair's offerings. It's also surprisingly quiet, and has a smooth, deep thrum that isn't unpleasant to hear. If you don't want to use a fan controller, and just want to hook up a fan to your radiator or case, it's a great choice for less than £10. However, dipping below 12V means it quickly becomes less effective.

**VERDICT**

An unbeatable balance of airflow and noise at 12V, but it quickly loses its prowess at lower voltages.

/SPECIFICATIONS

Max speed 1,000rpm
Stated noise 17.78dB(A)
PWM No
LEDs Yes
Extras None

12V		
PERFORMANCE	SOUND QUALITY	OVERALL SCORE
57/60	19/20	
FEATURES	VALUE	
5/10	7/10	88%

5V		
PERFORMANCE	SOUND QUALITY	OVERALL SCORE
28/60	19/20	
FEATURES	VALUE	
5/10	3/10	55%

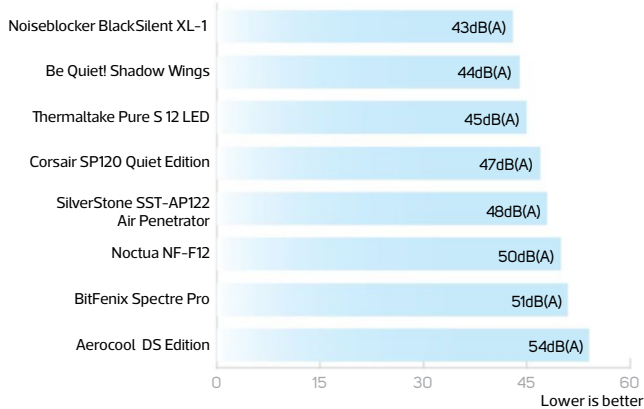
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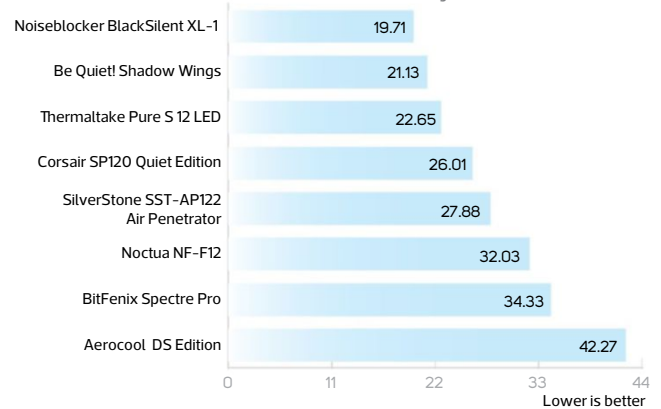
NOISE AT 5V

Raw result

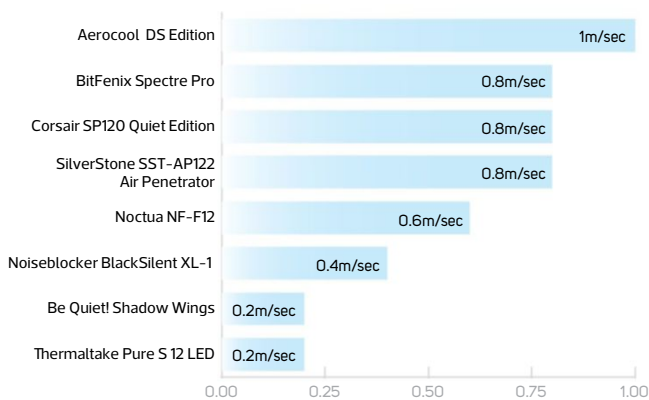


NOISE AT 5V

Calculation based on human hearing

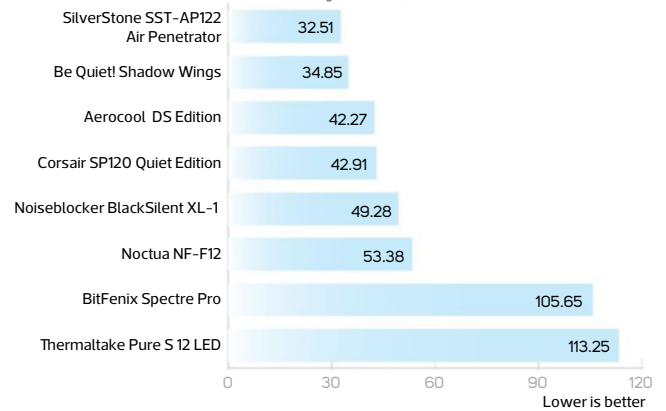


AIRFLOW AT 5V



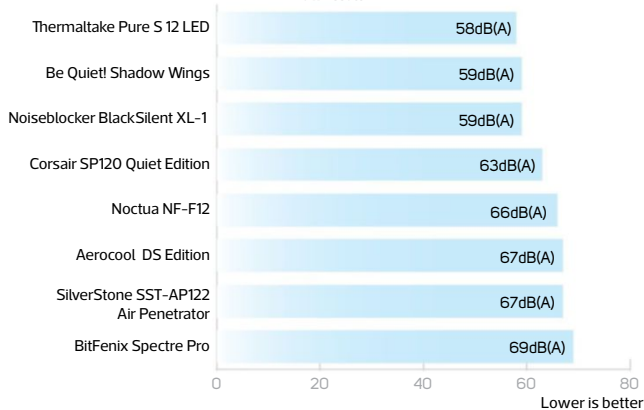
EFFICIENCY AT 5V

Noise (human hearing calculation) / airflow



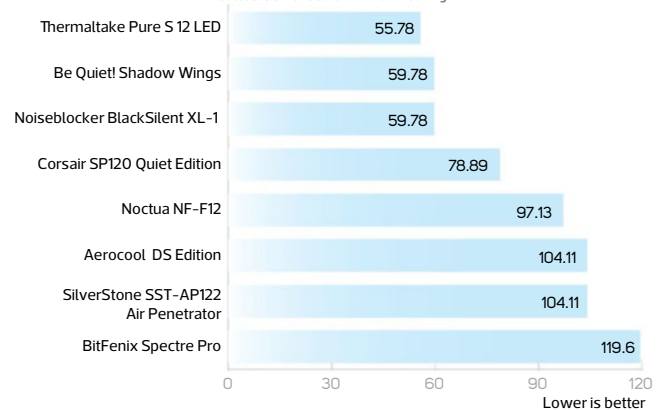
NOISE AT 12V

Raw result



NOISE AT 12V

Calculation based on human hearing

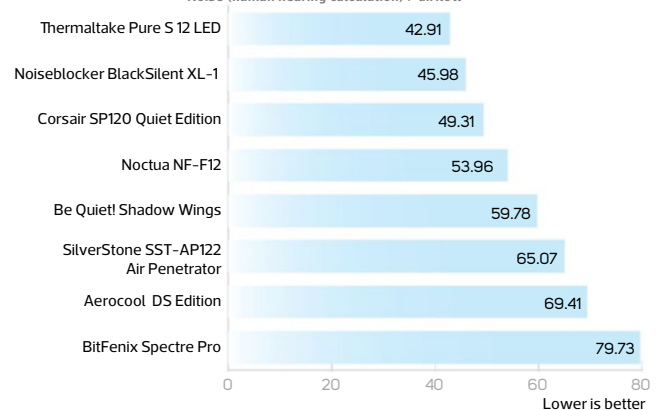


AIRFLOW AT 12V

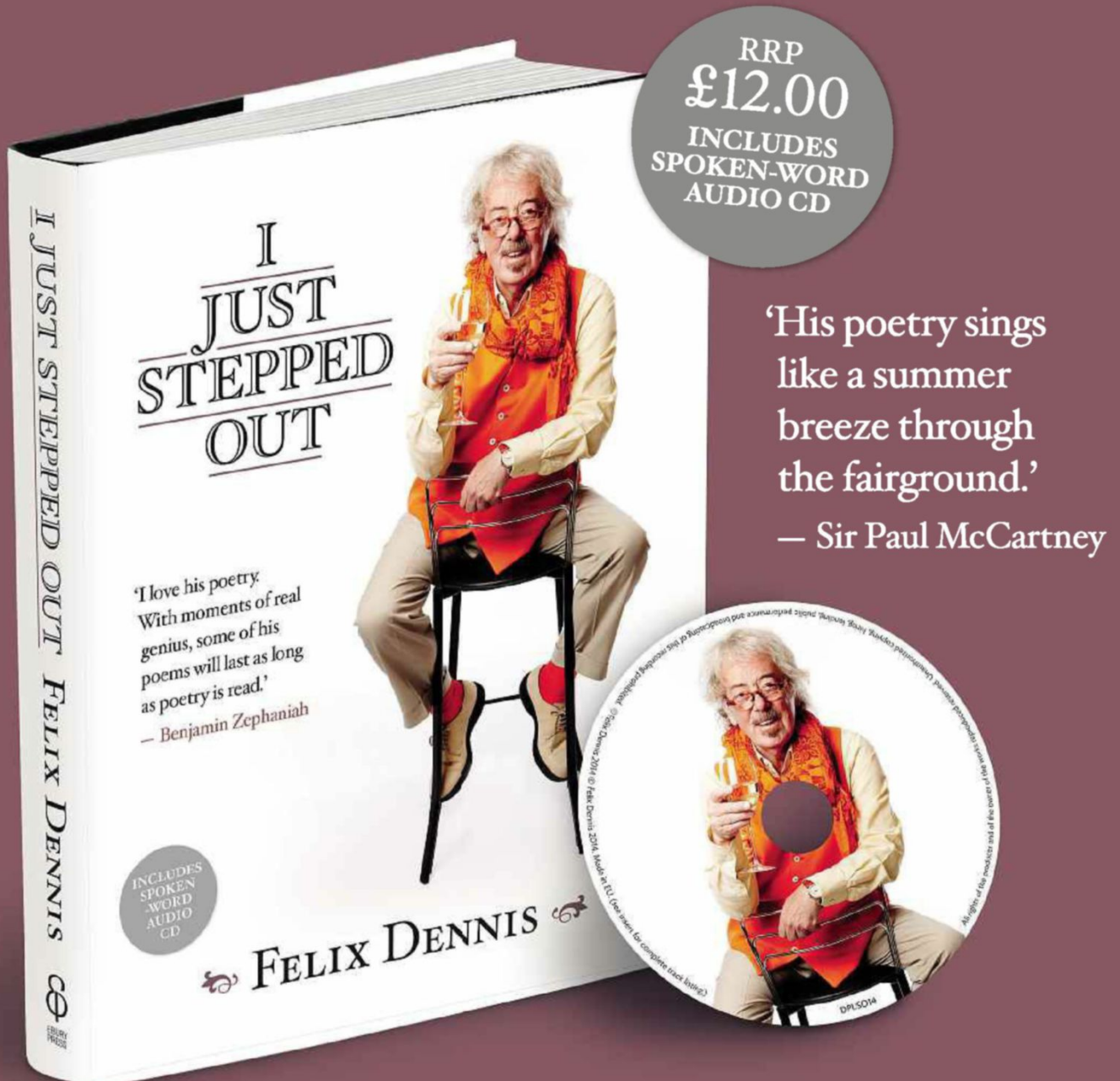


EFFICIENCY AT 12V

Noise (human hearing calculation) / airflow



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PC system reviews

GAMING PC

Scan 3XS Z170 Vengeance 1080 GL / £1,950 inc VAT

SUPPLIER www.scan.co.uk

There's no doubt about the star component in Scan's 3XS Z170 Vengeance 1080 GL – after all, it's in the name. Nvidia's factory-fresh GTX 1080 (see p26) is a barnstormer, using a 16nm FinFET manufacturing process to allow transistors and gates to branch off from a horizontal plane, so more transistors can be crammed into any one area.

The GTX 1080's GP104 core is a 314mm² chip with 7.2 billion transistors, while the GTX 980 was a 398mm² die with 5.2 billion transistors, and the numbers in the specs are incredible. The GTX 1080 has 2,560 stream processors and a 1607MHz core clock speed with an average boost of 1733MHz. It also has 8GB of GDDR5X memory, which has a colossal effective frequency of 10000MHz. Scan hasn't stopped there either – it's added 225MHz to the core and 200MHz to the memory.

Scan has backed up the GTX 1080 with decent components too. The familiar Core i7-6700K is overclocked to 4.6GHz, and it's paired with 16GB of 3000MHz DDR4 memory. The boot drive is a 512GB Samsung 950 Pro, which sits alongside a 2TB hard disk, and the PSU is a Corsair RM650x with an 80Plus Gold rating and a fully modular design. Meanwhile, the Asus Z170 Pro Gaming is solid: it

features SupremeFX audio, plenty of free expansion slots and smart heatsinks with customisable lights, and its backplate has four USB 3 ports alongside USB 3.1 Type-A and Type-C connectors.

The In Win 904 Plus mid-tower chassis makes a stylish first impression too. The fascia and roof are built with a 4mm-thick slab of aluminium that's sandwiched between two panels of thick, tempered glass. The whole chassis feels rock-solid, and it looks great – sleek and minimal.

The interior is reasonably well organised. The top has a removable storage cage with a couple of spare tool-free bays and smart pre-installed cables.

A huge cable-routing hole has been used well too – this machine meets Scan's usual high standards. The rear is immaculate, with smartly-routed cables, including a neat extension for the row of white LEDs.

Meanwhile, the CPU is chilled by a Noctua NH-C14S, which has been deployed because the In Win case is quite narrow. The Noctua is 140mm wide but only 115mm tall, which



means it's tricky to get to the spare memory slots without removing the cooler. Fortunately, other upgrade paths are easier to reach, thanks to the tidy interior.

The case has some odd design features though. For example, a section of the case's front is cut away to reveal a cavity designed for air intake, containing a 140mm fan. The cavity is also used for the 5.25in bay, power button and four USB 3 ports. The air intake is fine, but the low, side-facing ports and buttons aren't always easy to reach, and reaching the 5.25in bay is even trickier. Scan hasn't used the latter for this build though.

Also, as with In Win's 909 case (see Issue 154, p26), the motherboard sits in the middle, with a space between the rear of the motherboard and the back of the chassis. It's a space that would be ideal for adding a radiator for water cooling, but it seems wasted in this air-cooled PC, and it can make it tricky to unplug peripherals from the rear ports. That said, the chassis does look great.

Finally, Scan's three year warranty is generous, with a year of on site service followed by two years of return to base coverage, all including parts and labour.

Performance

There's no getting away from it: the GTX 1080 is a beast. It has enough power to play any game at 4K with top settings. None of our test games ever dropped below 30fps at 4K, and the 49fps minimum in The Witcher 3 is superb. There's simply no comparison to machines with last year's hardware. For example, the Zoostorm Stormforce Stryker

/SPECIFICATIONS

CPU 4GHz Intel Core i5-6700K
overclocked to 4.6GHz

Motherboard Asus Z170
Pro Gaming

Memory 16GB 3000MHz
Corsair Vengeance LPX DDR4

Graphics 8GB Nvidia GeForce
GTX 1080

Storage 512GB Samsung 950
Pro M.2 SSD; 2TB Seagate

Barracuda hard disk

Case In Win 904 Plus

Cooling CPU: Noctua NH-C14S

with 140mm fan; GPU: 1x

70mm fan; front: 1x 140mm fan;

rear: 1x 90mm fan

PSU Corsair RM650x 650W

Ports Front: 4 x USB 3, 2 x audio;

rear: 4 x USB 3, 2 x USB 2, 1 x

USB 3.1 Type-A, 1 x USB 3.1

Type-C, 1 x PS/2, 1 x Gigabit

Ethernet, 1 x optical S/PDIF,

5 x audio

Operating system Microsoft

Windows 10 Home 64-bit

Warranty Three years parts and

labour, with one year on site and

two years return to base

- 1** The star of the show is a Founder's Edition GeForce GTX 1080 graphics card
- 2** There's 512GB of NVMe solid state storage from the Samsung 950 Pro
- 3** The overclocked CPU is kept in check by a Noctua NH-C14S air cooler

(see p66) has a GTX 980 Ti and only managed a 31fps minimum in The Witcher 3 at 4K. Getting this level of gaming performance from a single-GPU machine is fantastic.

The Scan is no slouch in applications either. Its overclocked Core i7 processor delivered an overall RealBench 2015 score of 146,888, bolstered by great video encoding pace. That's enough oomph to handle high-end games and workloads – only tasks that require extreme multi-threading will benefit from a new Broadwell E chip (see p19).

Meanwhile, the NVMe 4x PCI-E 3 SSD delivered sequential read and write speeds of 1,926MB/sec and 1,256MB/sec respectively. They're strong results that put any SATA 6Gbps SSD to shame, and there's 512GB of this high-speed solid state storage too.

The high-end hardware, unusual case design and reliance on air cooling saw the Scan return slightly high temperature figures though. The CPU delta T topped out at 64°C, with the core temperature peaking at 87°C – it's within thermal limits, but still high – the three years of parts coverage will give you peace of mind here. Likewise, the GPU delta T of 59°C translates to an 82°C core peak. That isn't cool, but it's not dangerous either, and it's impressive given the sheer graphics power on offer, as well as the GPU overclock. The Scan kept down the noise too, maintaining a quiet, low-pitched fan whirr even during intense gaming workloads.

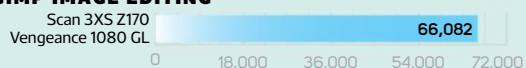


Conclusion

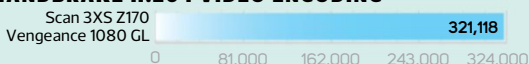
Nvidia's latest GPU brushes aside our 4K game tests, and Scan has backed it up with high-quality components in every other department. The case might have a couple of odd design quirks, but it looks fantastic. Most importantly, the speed of the GTX 1080 is incredible, with this machine looking set to churn out top-tier frame rates for a long time.

MIKE JENNINGS

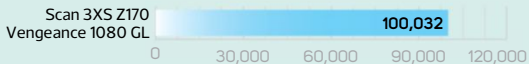
CPC REALBENCH 2015 GIMP IMAGE EDITING



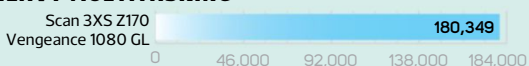
HANDBRAKE H.264 VIDEO ENCODING



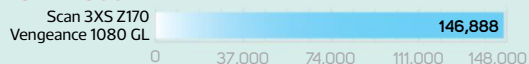
LUXMARK OPENCL



HEAVY MULTITASKING



SYSTEM SCORE



INTEL REFERENCE: 128.34%

SPEED
24/25

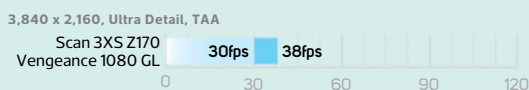
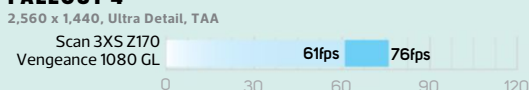
HARDWARE
24/25

DESIGN
22/25

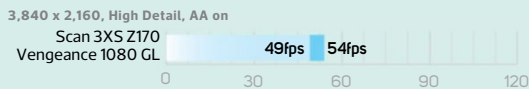
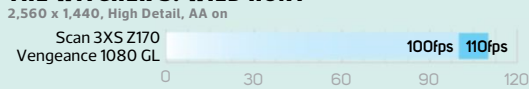
VALUE
22/25

OVERALL SCORE
92%

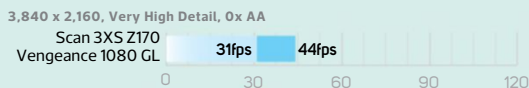
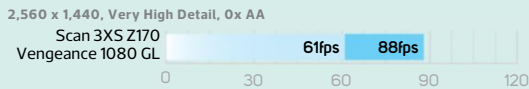
FALLOUT 4



THE WITCHER 3: WILD HUNT



CRYSIS 3



Minimum Average

VERDICT

Blistering speed from Nvidia's new GPU, and a PC that's good-looking, well built and carefully balanced in almost every other department.

GAMING PC

PC Specialist LS-E02 / £1,499 inc VAT

SUPPLIER www.pcspecialist.co.uk

The LS-E02 marks PC Specialist's long-planned move into proper water cooling, and it's a great first impression. The NZXT case is dominated by bright green cooling gear. This machine is prepped with PC Specialist's impressive entry-level water-cooling kit. There's a cylindrical Alphacool Pro 15 reservoir at the front, with a Phobya DC21-260 pump hidden in the empty 5.25in bays, while two tubes run between the processor's Heatkiller IV Basic waterblock and the 240mm Alphacool ST30 radiator hidden in the roof.

Meanwhile, the green Mayhems coolant is illuminated by bright blue LEDs, and the green and black theme continues to the braided cables. They look excellent, and they're tidy – shown off where applicable and kept hidden elsewhere.

The bright cooling hardware is installed into NZXT's Phantom 410 case. It's a striking mid-tower with plenty of

mesh, numerous angled sections and a monochrome colour scheme. The metal and plastic used is sturdy, and the Phantom offers three fan speeds. It also has four USB ports on the top, a door at the front and tool-free drive cages, with PC Specialist using its own brand of case fans throughout.

The NZXT looks good and has been used well, but PC Specialist has had to remove the main hard disk cage to fit the reservoir, and the three empty 5.25in bays are blocked by the pump. That won't matter unless you want to add an optical drive or extra storage, but it's a trade-off worth consideration.

This mid-range machine uses an Intel Core i5-6600K overclocked from 3.5GHz frequency to 4.6GHz, which should be great for games. Meanwhile, the graphics card is an XFX DD Black Edition Radeon R9 390X, with large fans and high-end cooling. The core has only been overclocked from 1050MHz to 1060MHz, and the 8GB of memory sits at its stock speed.

You can add more GPU power too, thanks to the Corsair RM850x PSU. It's fully modular with an 80Plus Gold rating, and its 850W output is huge – the machine's power draw topped out at 437W, so there's

still ample headroom for a second GPU.

Elsewhere, the PC Specialist's specification is standard. The 16GB of 2666MHz DDR4 memory is plenty, and there's a 500GB Samsung 850 Evo SSD alongside a 2TB Western Digital Black hard disk.

The Asus Z170-E motherboard only ticks basic boxes though – it's packed with PCI-E slots and SATA ports, but there aren't any on-board buttons or high-end features, and it looks a little plain compared with Asus' pricier offerings. The most interesting upgrade feature is the free M.2 slot, which can be used to deploy faster storage. The backplate is similarly mixed. It has USB 3.1 Type-C, but there's no sign of Type-A – and there are only two USB 3 ports.

Finally, the LS-E02 sports PC Specialist's standard warranty, which is a three year labour deal with a month of collect and return cover and a year of parts coverage.

Performance

The R9 390X happily ran all our test games at 1080p and 2,560 x 1,440, never dropping below 36fps at the latter resolution. However, its best 4K minimum was a barely playable 27fps in The Witcher 3, and the other 4K results weren't even playable. As a point of comparison, the Chillblast Fusion Brimstone (see Issue 152, p62) currently costs £1,550 inc VAT, and while it doesn't have a proper water-cooling loop, its pair of GTX 980 cards are much quicker at 4K than the R9 390X. The Chillblast managed a minimum of 31fps in Fallout 4 at 4K, for example.

On the plus side, the PC Specialist's overclocked Core i5 CPU delivered a solid image editing score of 64,048, thanks to its 4.6GHz overclock and an overall score of 123,563 – a fine result that shows this machine will handle work and play well. That's also faster than the aforementioned Chillblast due to a higher overclock, courtesy of the cooling system, which offers amazing performance – the CPU's peak delta T of 37°C is excellent. Despite being air cooled and using AMD's notoriously hot-running Radeon R9 390X GPU, the GPU peak delta E of 51°C is also fine.

In terms of noise, there's a noticeable low rumble when the system is idle or running low-intensity tasks, and that noise becomes a little louder during stress tests – it's a tad noisier than the average mid-range gaming system, but it isn't loud enough to cause any issues, and the cool temperatures mean there's no need to deploy more aggressive fan settings.

/SPECIFICATIONS

CPU 3.5GHz Intel Core i5-6600K
overclocked to 4.6GHz

Motherboard Asus Z170-E

Memory 16GB 2666MHz
Kingston HyperX Fury DDR4

Graphics XFX AMD Radeon R9
390X 8GB

Storage 500GB Samsung 850
Evo SSD; 2TB Western Digital
Black hard disk

Case NZXT Phantom 410

Cooling CPU: Heatkiller IV Basic
waterblock with Alphacool ST30
240mm radiator, Alphacool Pro
15 reservoir, Phobya DC21-260
pump and two 120mm fans; GPU:
2 x 90mm fans; front: 1x 120mm
fan; rear: 1x 120mm fan

PSU Corsair RMx850 850W

Ports Front: 2 x USB 3, 2 x USB 2,
2 x audio; rear: 2 x USB 3, 2 x USB
2, 1x USB 3.1 Type-C, 1x Gigabit
Ethernet, 1x PS/2, 6 x audio

Operating system Microsoft
Windows 10 Home 64-bit

Warranty One year parts and
labour return to base, with first
month collect and return,
followed by two years labour only



1

Thanks to water cooling, the CPU delta T only peaked at 37°C

2

Even the PSU cables are colour-matched with the green Mayhems coolant

3

The 850W modular Corsair PSU offers plenty of room for GPU upgrades

Meanwhile, the 500GB Samsung Evo SSD delivered sequential read and writes of 518MB/sec and 467MB/sec respectively, which is fine for a SATA 6Gbps drive. An NVMe PCI-E drive would be much quicker, but the Evo is still quick enough for most people.

Conclusion

PC Specialist's impressive water-cooling debut proves the company can professionally assemble a PC with custom water-cooling gear without breaking the bank. This entry-level loop does a grand job of keeping the CPU chilled, and the lighting and coolant look great. The new range is versatile too – you can choose different levels of cooling gear, coolant colours, various braided cables and different GPU options.

However, the use of a R9 390X GPU means you can get faster 4K gaming performance for less money elsewhere, and the GPU isn't water-cooled either. There's no M.2 SSD, and in some minor areas the case is compromised by the cooling – it's a tad loud.

Also, the entry-level water-cooling loop only cools the CPU, and PC Specialist doesn't recommend adding a GPU block to it either – you ideally want the company's Mid kit to

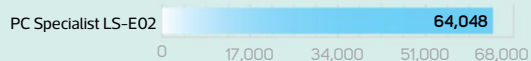


add GPU cooling. At this price, unless you have your heart set on low-cost water cooling, we'd opt for a plainer system with more gaming power and, if you want custom water cooling, spending a little more money on one of PC Specialist's pricier systems with a water-cooled, faster graphics setup.

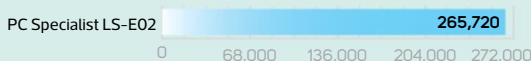
MIKE JENNINGS

CPC REALBENCH 2015

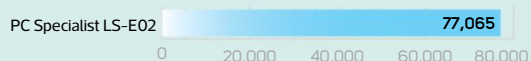
GIMP IMAGE EDITING



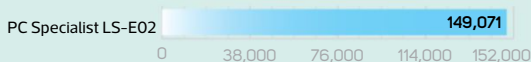
HANDBRAKE H.264 VIDEO ENCODING



LUXMARK OPENCL



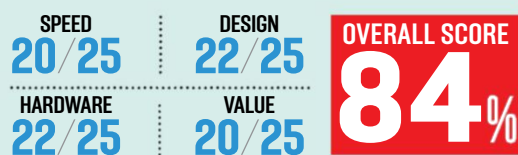
HEAVY MULTITASKING



SYSTEM SCORE



INTEL REFERENCE: **107.96%**

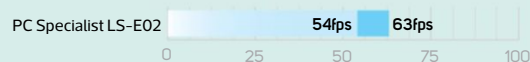


VERDICT

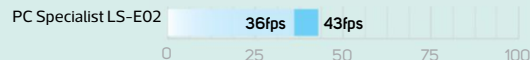
A good-looking and effective CPU water-cooling system for a good price, but we'd advise spending a bit more to get a faster, water-cooled graphics setup.

FALLOUT 4

1,920 x 1,080, Ultra Detail, TAA



2,560 x 1,440, Ultra Detail, TAA

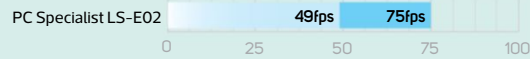


3,840 x 2,160, Ultra Detail, TAA

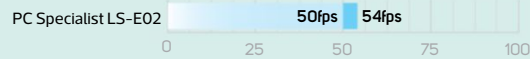


THE WITCHER 3: WILD HUNT

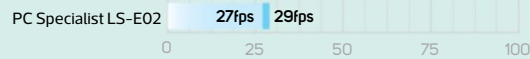
1,920 x 1,080, High Detail, AA on



2,560 x 1,440, High Detail, AA on

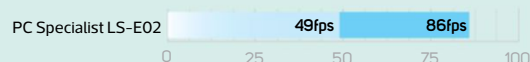


3,840 x 2,160, High Detail, AA on



CRYSIS 3

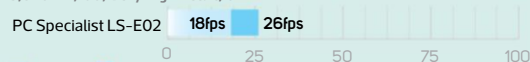
1,920 x 1,080, Very High Detail, 0x AA



2,560 x 1,440, Very High Detail, 0x AA



3,840 x 2,160, Very High Detail, 0x AA



Minimum Average

GAMING PC

Zoostorm Stormforce Stryker / **£1,800** inc VATSUPPLIER www.argos.co.uk

There's no denying that Zoostorm's Stormforce Stryker is a full-fat gaming desktop – its CM Storm Stryker chassis pairs its huge dimensions with a striking design. It's black and white, and it's angular, with fins and jutting metal. The front is dominated by a column of removable bay covers, and the top has slats, mesh and a huge power button that glows red. It also measures 606mm tall and weighs nearly 18kg – this machine really makes an impact.

It's packed with features too. The top has a padded handle and a tray underneath it for peripheral storage, and the button cluster offers light and fan control, turning the white fan LEDs on or off, and providing a selection of three fan speeds. The versatility continues elsewhere. There are removable 3.5in and 2.5in drive cages in the case's main cavity, a spare 5.25in bay at the top, and a front-facing 2.5in bay called the X-Dock. The bottom of the front panel even has a removable CM Storm logo, which hides a tray for tools, screws and so on. Removable dust filters can be found everywhere, and cooling is handled by two 120mm fans at the front and a vast 200mm spinner in the roof.

It's so big that the Zoostorm's ATX motherboard is dwarfed by the white motherboard tray. It's a similar story with the full-sized PSU, which looks tiny in the bottom of this case. The only issue with the case is inconsistent build quality. Most of the metal used to build the underlying frame is sturdy enough, but the plastic feels weaker, and creaks and rattles if you provoke it.

Zoostorm has deployed a familiar combination of key components inside the Stormforce, with Intel's Core i7-6700K alongside a KFA² GeForce GTX 980 Ti card.

The processor is overclocked from 4GHz to 4.4GHz, while the GTX 980 Ti stays at its stock speed. The CPU is chilled by a Thermalright Water 3.0 cooler, and the graphics card is air-cooled with a reference cooler.

Those core parts trade blows with the £1,850 Box Cube Oblivion (see Issue 154, p62), which used a 568mm tall Corsair Carbide 760T a case, with a subtler design and some interesting features, including an Asus Republic of Gamers Front Base. That system ran its i7-6700K at a swifter 4.7GHz, but it only had a GTX 980 graphics card – the GTX 980 Ti card in the Zoostorm should enable 4K gaming.

The rest of the Zoostorm specification is mixed. There's 32GB of 2400MHz DDR4 memory, which is a lot, but overkill for most people, especially gamers, needlessly bumping up the price. It's also good to see a 512GB SSD, but the Zoostorm's SanDisk X400 won't be able to compete with the Box's



Samsung M.2 SSD. On the plus side, there's a massive 4TB hard drive for data storage.

The motherboard isn't a barnstormer either. The ASRock Z170 Pro4S ticks every basic box – including having a spare M.2 socket beneath the graphics card – but it lacks high-end features. It doesn't have any on-board buttons or USB 3.1 ports. Comparatively, the Box's Asus Maximus VIII Hero is a much better board.

The motherboard's looks are underwhelming too. It has a plain black PCB and copper heatsinks, while the Box's Hero board had decorative heatsinks with customisable lights. It doesn't affect performance, but these factors are important in an extravagant rig with a huge window and an illuminated interior. The Stryker's huge window also reveals comparatively untidy cabling. Wires are left to hang free or have barely been tied down, and there's no sign of sleeved cables or other visual improvements. The PSU doesn't help here either, as the Sparkle Power FSP750 isn't modular, although it does have an 80Plus Silver accreditation.

Finally, Zoostorm's machine includes a one year return to base warranty, covering both parts and labour, but that's it. Comparatively, the Box has a two year parts and labour deal, with a year of collect and return coverage.

Performance

The Zoostorm's GTX 980 Ti proved capable at all resolutions, never dropping below 40fps in any of our test games at 2,560 x 1,440. It just managed to be capable of 4K gaming too. It stayed above our 25fps minimum target in two games, and it will only take a little tweaking to make its 23fps minimum in Crysis 3 playable.

Those results illustrate clear ground between the Zoostorm's GTX 980 Ti and the Box's GTX 980. That rig is capable at 1080p and 1440p gaming, but it only managed

/SPECIFICATIONS

CPU 4GHz Intel Core i7-6700K
overclocked to 4.4GHz

Motherboard ASRock Z170
Pro4S

Memory 32GB Kingston
HyperX Fury 2400MHz DDR4

Graphics KFA² GeForce GTX
980 Ti 6GB

Storage 512GB SanDisk X400
SSD; 4TB Western Digital Blue
hard disk

Case CM Storm Stryker

Cooling CPU: Thermalright
Water 3.0 Performance with
1x 120mm fan; GPU: 1x 70mm
fan; front: 2 x 120mm fans; top:
1x 200mm fan

PSU Sparkle Power FSP750-
50ERN

Ports Front: 2 x USB 3, 2 x USB
2, 2 x audio; rear: 6 x USB 3,
1x PS/2, 1x Gigabit Ethernet,
3 x audio

Operating system Microsoft
Windows 10 Home 64-bit

Warranty One year return to
base, covering parts and labour

- 1** The KFA² GeForce GTX 980 Ti card makes for a decent gaming machine
- 2** A massive 32GB bank of 2400MHz DDR4 memory is included
- 3** Zoostorm could take more care with cable tidying, and tie down some of the cables

minimums of 21fps and 22fps in Fallout 4 and Crysis 3, and its averages were even further behind the Zoostorm.

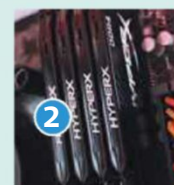
Those positions were reversed in our application benchmarks. The Zoostorm's overclocked Core i7 makes it extremely fast, but not quite as quick as the Box machine, which is no surprise with the latter's higher overclock. That said, the Zoostorm's overall result of 139,061 is still excellent – ample for games and demanding work tasks.

In other departments, the Zoostorm was more ordinary. The SanDisk SATA SSD's sequential read and write speeds of 459MB/sec and 269MB/sec are inconsistent – the former result is decent, but the latter is disappointing, and neither speed matches an NVMe 4x PCI-E 3 M.2 drive.

Meanwhile, the CPU and GPU's peak delta E temperature results of 51°C and 60°C are fine, staying well away from dangerous levels, and the Zoostorm's noise level was middling. The Zoostorm churned out a low rumble with the fans on the lowest setting, at which the PC is supplied. The fan noise isn't inaudible, but the Zoostorm was always quieter than the Box and its loud, modulating fans.

Conclusion

The Zoostorm Stormforce Stryker makes a bold first impression with its huge, feature-filled case, and its GTX 980 Ti graphics and overclocked Core i7 processor ensure



solid core performance: enough power for 4K gaming and enough application ability for work and play.

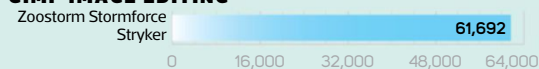
Get beyond the benchmarks, though, and this system disappoints. The motherboard is basic for a machine in this price league, the SSD could be quicker and the build quality is middling.

It's great to see a high-end GeForce GTX 980 Ti system housed in such a striking case, though, and with a little more attention to detail, Zoostorm could be on to a winner.

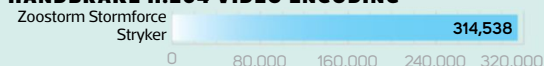
MIKE JENNINGS

CPC REALBENCH 2015

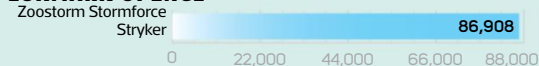
GIMP IMAGE EDITING



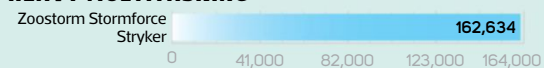
HANDBRAKE H.264 VIDEO ENCODING



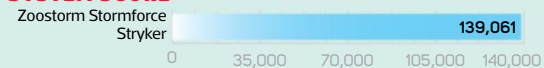
LUXMARK OPENCL



HEAVY MULTITASKING



SYSTEM SCORE



INTEL REFERENCE: 121.5%

SPEED
20/25

DESIGN
19/25

HARDWARE
20/25

VALUE
19/25

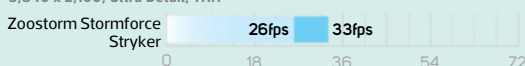
OVERALL SCORE
78%

FALLOUT 4

2,560 x 1,440, Ultra Detail, TAA



3,840 x 2,160, Ultra Detail, TAA



THE WITCHER 3: WILD HUNT

2,560 x 1,440, High Detail, AA on, HairWorks off



3,840 x 2,160, High Detail, AA on, HairWorks off



CRYSIS 3

2,560 x 1,440, Very High Detail, 0x AA



3,840 x 2,160, Very High Detail, 0x AA



VERDICT

Solid speed in key benchmarks, including 4K gaming abilities, but a lack of care and balance elsewhere hinders this gaming rig.

Elite

Our choice of the best hardware available

Build a home theatre PC

The parts you'll need to build an affordable, home theatre PC that's ideal for putting in the lounge and playing back all manner of video formats. This machine will handle general computing and media tasks with no trouble, and its dual-core Skylake CPU can even handle 4K video playback. Meanwhile, its super-quiet Noctua CPU cooler prevents it from making a racket.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Lian Li PC-Q09FNB with 300W FSP SFX PSU	www.overclockers.co.uk	Issue 149, p92	£110
	Intel Core i3-6100T	www.overclockers.co.uk	Issue 149, p92	£96
	Asus H110i-Plus D3	www.scan.co.uk	Issue 149, p92	£59
	8GB Corsair 2133MHz Vengeance LP DDR3 (CML8GX3M2A2133C11B)	www.scan.co.uk	Issue 149, p92	£41
	Noctua L9i	www.scan.co.uk	Issue 149, p93	£32
	Samsung SN-208FB	www.scan.co.uk	Issue 149, p93	£14
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£53
	Samsung 850 Evo 250GB	www.scan.co.uk	Issue 141, p51	£75
	Logitech K400 Plus	www.scan.co.uk	Issue 149, p93	£30
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£85
			TOTAL	£595



STRIX

GEFORCE® GTX 10 SERIES
Outshine The Competition



Build a budget gaming PC

The parts you'll need to build a budget machine capable of playing the latest games at maximum settings on a 1080p monitor, and even some games at 2,560 x 1,440. The machine has a discrete graphics card, a Skylake dual-core CPU and DDR4 memory. The ASRock Extreme4 motherboard is also capable of base clock overclocking via a BIOS update.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	NZXT S340	www.overclockers.co.uk	Issue 137, p54	£60
	ASRock Z170 Extreme4	www.scan.co.uk	Issue 151, p84	£108
	Intel Core i3-6100	www.scan.co.uk	Issue 151, p18	£95
	8GB (2 x 4GB) Corsair Vengeance LPX 2400MHz (CMK8GX4M2A2400C16)	www.scan.co.uk	Issue 151, p83	£31
	Asus Radeon R9 380 Strix 2GB	www.ebuyer.com	Issue 150, p48	£154
	Samsung 850 Evo 250GB	www.scan.co.uk	Issue 141, p51	£75
	SilverStone Argon AR01	www.scan.co.uk	Issue 132, p57	£26
	EVGA SuperNova GS 550W	www.scan.co.uk	Issue 146, p50	£70
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£53
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£85
			TOTAL	£757



STRIX GTX 980 TI










**BREAK
THE RULES**



Build a mid-range PC

Work PC

The parts you'll need to build a solid quad-core PC with plenty of upgrade potential. This kit list gives you an all-in-one liquid cooler and a K-series Core i5 Skylake CPU, meaning you can overclock it and get some serious processing power. We've managed to get the Core i5-6600K Skylake CPU up to 4.6GHz, so it has some great performance potential. Also included is a solid EVGA PSU, a fast M.2 SSD and 8GB of high-speed DDR4 memory. The core configuration assumes you won't be doing any serious gaming, however, and it relies on Intel's integrated graphics.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	NZXT H440 2015 Edition	www.overclockers.co.uk	Issue 154, p50	£95
	Asus Maximus VIII Ranger	www.scan.co.uk	Issue 147, p44	£150
	Intel Core i5-6600K	www.scan.co.uk	Issue 145, p17	£193
	8GB Corsair Vengeance LPX 2666MHz DDR4 (CMK8GX4M2A2666C16)	www.scan.co.uk	Issue 145, p24	£37
	NZXT Kraken X41	www.overclockers.co.uk	Issue 138, p57	£80
	EVGA SuperNova GS 550W	www.scan.co.uk	Issue 146, p50	£70
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£53
	Samsung SSD 950 Pro 256GB	www.ebuyer.com	Issue 149, p48	£138
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£85
			TOTAL	£901

Gaming PC

The graphics card you'll need to play current games at their maximum settings at 1080p and 2,560 x 1,440.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	1,920 x 1,080 Asus Radeon R9 380 Strix 2GB	www.ebuyer.com	Issue 150, p48	£154
	2,560 x 1,440 Asus Strix GTX 970	www.scan.co.uk	Issue 150, p39	£276

ASUS
IN SEARCH OF INCREDIBLE

ROG MAXIMUS VIII FORMULA Z170 GAMING MOTHERBOARD










PERFECT YOUR BUILD
FROM **COOLING** TO **COLOUR**



Build a performance PC

Work PC

The parts you'll need to build a high-quality, fast PC that's ideal for multi-threaded workloads. This kit list features a high-quality, well-built case, a feature-rich motherboard and an Intel Skylake Core i7-6700K CPU. This processor's support for Hyper-Threading splits the resources of the CPU's four physical cores into a further four virtual cores, meaning it can effectively handle eight threads at once. There's also a solid Corsair 750W PSU, giving you plenty of headroom for overclocking and adding another GPU, 16GB of DDR4 memory, a high-speed M.2 SSD and an all-in-one liquid cooler.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Cooler Master Cosmos SE	www.cclonline.com	Issue 144, p41	£144
	Asus Maximus VIII Hero	www.overclockers.co.uk	Issue 146, p20	£185
	Intel Core i7-6700K	www.scan.co.uk	Issue 145, p17	£281
	16GB Corsair Vengeance LPX 2666MHz DDR4 (CMK16GX4M2A2666C16)	www.scan.co.uk	Issue 145, p24	£59
	NZXT Kraken X41	www.overclockers.co.uk	Issue 138, p57	£80
	Corsair RM750i	www.scan.co.uk	Issue 146, p55	£110
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£53
	Samsung SSD 950 Pro 512GB	www.ebuyer.com	Issue 149, p48	£244
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£85
			TOTAL	£1,241

Gaming PC

The graphics card you'll need to play current games at their maximum settings at 2,560 x 1,440 and beyond.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	2,560 x 1,440 Asus Strix GTX 970	www.scan.co.uk	Issue 150, p39	£280
	4K Nvidia GeForce GTX 1080 Founders Edition	www.scan.co.uk	Issue 155, p26	£619

UPDATED



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ROG MAXIMUS VIII HERO ALPHA
LIGHT UP AS EASY AS RGB
WITH INTEGRATED RGB HEADERS



Build a high-end 6-core PC

Multi-threaded PC

The parts you'll need to build a PC with serious power in multi-threaded software, such as 3D rendering apps, video editing programs and optimised distributed computing software. The kit list features a 6-core LGA2011-v3 CPU, which is overclockable using the motherboard and top-end cooler listed. Also supplied is 16GB of RAM, a super-fast M.2 SSD, 1TB of extra solid state storage and Asus' superb X99 Deluxe motherboard.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Phanteks Enthoo Luxe	www.eclipsecomputers.com	Issue 144, p53	£117
	Asus X99 Deluxe	www.scan.co.uk	Issue 136, p20	£331
	Intel Core i7-5820K	www.scan.co.uk	Issue 134, p43	£320
	Asus Radeon R9 380 Strix 2GB	www.ebuyer.com	Issue 150, p48	£154
	16GB Corsair Vengeance LPX 2666MHz DDR4 (CMK16GX4M4A2666C16)	www.scan.co.uk	Issue 136, p14	£74
	EKWB EK-Predator 240 Rev 1.1	www.scan.co.uk	Issue 148, p30	£164
	Corsair RM750i	www.scan.co.uk	Issue 146, p55	£110
	Samsung SSD 950 Pro 512GB	www.ebuyer.com	Issue 149, p48	£244
	Samsung 850 Evo 1TB	www.cclonline.com	Issue 141, p51	£250
	Lite-On IHAS124-14	www.shop.bt.com	Issue 99, p108	£10
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£85
			TOTAL	£1,859

4K gaming PC

Add a single GeForce GTX 1080 graphics card to enable 4K gaming on this system, or take advantage of its 28 PCI-E 3 lanes and add multiple GPUs.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	4K Nvidia GeForce GTX 1080 Founders Edition	www.scan.co.uk	Issue 155, p26	£619
			TOTAL	£2,324

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ROG MAXIMUS VIII HERO

**PLAY TO YOUR
STRENGTHS**











**16 AWARDS
AND
COUNTING**



Build a mini PC

Core components

The parts you'll need to build either PC. This kit list gives you a solid PSU, 16GB of RAM, an overclockable Skylake CPU, an all-in-one liquid cooler and Windows 10 Home 64-bit. Also included is a short-PCB graphics card that can play current games at their maximum settings at 2,560 x 1,440, and a high-speed M.2 SSD.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Intel Core i7-6700K	www.scan.co.uk	Issue 147, p84	£281
	16GB (2 x 8GB) Corsair Vengeance LPX 2666MHz	www.scan.co.uk	Issue 147, p84	£59
	Corsair H80i GT	www.ebuyer.com	Issue 147, p84	£75
	Asus Strix GTX 970	www.scan.co.uk	Issue 150, p39	£280
	Samsung SSD 950 Pro 512GB	www.ebuyer.com	Issue 149, p48	£244
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£53
	EVGA SuperNova GS 550W	www.scan.co.uk	Issue 146, p50	£70
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£85



Mini-ITX PC

The parts you'll need to build a pint-sized powerhouse.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Fractal Design Define Nano S	www.scan.co.uk	Issue 153, p22	£60
	Asus Z170i Pro Gaming	www.eclipsecomputers.com	Issue 147, p26	£124
			TOTAL	£1,331

Micro-ATX PC

The parts you'll need to build a mini PC that doesn't take up as much room as a full-sized desktop.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Fractal Design Arc Mini R2	www.scan.co.uk	Issue 127, p46	£70
	Asus Maximus VIII Gene	www.overclockers.co.uk	Issue 147, p42	£174
			TOTAL	£1,391










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MAXIMUS VIII IMPACT
**MINI SIZE.
MAXIMUM WINS.**



Cases

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Budget ATX	NZXT S340	www.overclockers.co.uk	Issue 137, p54	£60
	Sub-£100 ATX quiet	Fractal Design Define R5	www.scan.co.uk	Issue 137, p20	£80
	Sub-£100 ATX performance	NZXT H440 2015 Edition	www.overclockers.co.uk	Issue 154, p50	£95
	Sub-£150 full-sized ATX quiet	Nanoxia Deep Silence 5	www.quietpc.com	Issue 144, p50	£129
	Sub-£150 full-sized ATX	Phanteks Enthoo Luxe	www.eclipsecomputers.com	Issue 144, p53	£117
	Sub-£150 mid-size ATX	Cooler Master Cosmos SE	www.cclonline.com	Issue 144, p41	£144
	Mini-ITX tower	Fractal Design Define Nano S	www.scan.co.uk	Issue 153, p22	£60
	Mini-ITX cube	Fractal Design Core 500	www.scan.co.uk	Issue 150, p20	£50
	Micro-ATX	Fractal Design Arc Mini R2	www.scan.co.uk	Issue 127, p46	£70

Graphics cards

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	1,920 x 1,080 gaming	Asus Radeon R9 380 Strix 2GB	www.ebuyer.com	Issue 150, p48	£154
	2,560 x 1,440 gaming	Asus Strix GTX 970	www.scan.co.uk	Issue 150, p39	£280
	4K gaming	Nvidia GeForce GTX 1080 Founders Edition UPDATED	www.scan.co.uk	Issue 155, p26	£619
	Mini-ITX	Asus GeForce GTX 970 DirectCU Mini	www.cclonline.com	Issue 150, p38	£265

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Unleash your
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**PC
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Power supplies

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Mid-range 550W	EVGA SuperNova GS 550W	www.scan.co.uk	Issue 146, p50	£70
	High-end 550W	Super Flower Leadex Platinum 550W	www.overclockers.co.uk	Issue 146, p52	£88
	Mid-range 750W	Corsair RM750i	www.scan.co.uk	Issue 146, p55	£110
	High-end 1.2kW	Corsair Professional Series AX1200i	www.scan.co.uk	Issue 111, p40	£275

Networking

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Router	Asus RT-AC68U	www.cclonline.com	Issue 128, p88	£149
	Wi-Fi adaptor	Asus PCE-AC68	www.cclonline.com	Issue 128, p88	£65

Storage







	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Hard disk	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£53
	250GB SATA SSD	Samsung 850 Evo 250GB	www.scan.co.uk	Issue 141, p51	£75
	1TB SATA SSD	Samsung 850 Evo 1TB	www.cclonline.com	Issue 141, p51	£250
	High-performance M.2 SSD	Samsung SSD 950 Pro 512GB	www.ebuyer.com	Issue 149, p48	£244
	NAS box	Synology DS216j	www.ebuyer.com	Issue 154, p28	£131

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ASUS X99 SERIES MOTHERBOARDS
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Monitors

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	24in monitor	Dell U2414H	www.overclockers.co.uk	Issue 129, p43	£189
	27in 2,560 x 1,440 FreeSync monitor	Acer XF270HU UPDATED	www.overclockers.co.uk	Issue 155, p46	£379
	27in 2,560 x 1,440 G-Sync monitor	Asus ROG Swift PG279Q UPDATED	www.ebuyer.com	Issue 155, p48	£669
	27in 4K G-Sync monitor	Asus ROG Swift PG27AQ	www.scan.co.uk	Issue 151, p42	£674
	27in 5K monitor	Dell UltraSharp UP2715K	www.scan.co.uk	Issue 151, p44	£755
	34in ultra-wide curved G-Sync monitor	Asus ROG Swift PG348Q	www.scan.co.uk	Issue 153, p28	£999

Peripherals







	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Mechanical gaming keyboard	Cooler Master MasterKeys Pro S (Pro L version recommended if you need a numeric keypad)	www.scan.co.uk	Issue 152, p44	£110
	Premium mechanical gaming keyboard	Corsair Gaming K70 RGB Rapidfire	www.scan.co.uk	Issue 154, p21	£150
	Budget gaming mouse	Cooler Master Xornet II	www.cclonline.com	Issue 149, p28	£20
	Gaming mouse	Logitech G402 Hyperion Fury	www.scan.co.uk	Issue 139, p53	£41
	Ambidextrous gaming mouse	Roccat Kova	www.cclonline.com	Issue 150, p28	£48
	MMO gaming mouse	Corsair Scimitar RGB	www.cclonline.com	Issue 150, p17	£72
	Wireless gaming mouse	SteelSeries Sensei Wireless	www.overclockers.co.uk	Issue 139, p61	£110


STRIX
X99 GAMING MOTHERBOARD
The Gamer's Edge for X99


Audio

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	PCI-E sound card	Asus Strix Raid DLX	www.scan.co.uk	Issue 148, p28	£150
	2.1 speakers	Acoustic Energy Aego M	www.amazon.co.uk	Issue 142, p52	£129
	Soundbar	Razer Leviathan	www.overclockers.co.uk	Issue 142, p57	£160
	Headset	HyperX Cloud II	www.scan.co.uk	Issue 142, p46	£73
	Surround-sound headset	Asus Strix 7.1	www.shop.bt.com	Issue 142, p43	£126

Systems

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Quiet gaming PC	Scan 3XS Z170 Vengeance	www.scan.co.uk	Issue 151, p60	c.£1,500
	Dream PC	Scan 3XS Barracuda	www.scan.co.uk	Issue 145, p58	c.£9,499
	Sub-£2,000 gaming PC	Scan 3XS Z170 Vengeance 1080 GL UPDATED	www.scan.co.uk	Issue 155, p62	£1,950
	Mini-ITX gaming PC	Chillblast Fusion Fury Nano	www.chillblast.co.uk	Issue 147, p56	c.£1,619
	Premium mini-ITX PC	Overclockers 8Pack Asteroid	www.overclockers.co.uk	Issue 154, p56	c.£3,990
	Premium PC	Scan 3XS X99 Carbon Extreme SLI	www.scan.co.uk	Issue 148, p62	c.£4,799
	Water-cooled PC	Overclockers Infin8 Toxicity	www.overclockers.co.uk	Issue 150, p58	c.£3,414
	Gaming laptop	CyberPower Fangbook 4 SK-X17	www.cyberpowersystem.co.uk	Issue 152, p30	c.£1,909
	Thin and light gaming laptop	Scan 3XS LG15 Vengeance G-Sync	www.scan.co.uk	Issue 153, p51	c.£1,480

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**X99 SIGNATURE
SERIES MOTHERBOARDS**
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Games



Featured this month

Inverse look p79 / Doom p80 / The Banner Saga 2 p82 / Everybody's Gone to the Rapture p82 /
Shadow Complex Remastered p84 / The engine room – Twine p86



RICK LANE / INVERSE LOOK

PEACE WALKS

First-person non-combat games are a great idea, but when you take the 'S' from 'FPS', you need to replace it with something else, argues Rick Lane

This month I've been playing *Everybody's Gone to the Rapture* (see p82), the latest game by Dear Esther developer TheChineseRoom – the British developer known as the pioneer of the 'walking simulator' genre. *Rapture* takes place in a stunning, distinctly British slice of countryside, and uses this environment as a backdrop to tell a story. There's plenty to like, but it's hamstrung by the world being almost completely static, with hardly any possible interaction, like a film set where the director is terrified the façades will collapse if the actors touch them.

Rapture isn't the only game of its ilk that suffers from this problem. I don't really like the term 'walking simulators', preferring instead to call them 'first-person adventures', but the former description is sometimes depressingly appropriate. Other examples such as *The Vanishing of Ethan Carter*, *Ether One* and *The Old City: Leviathan* offer an awful lot to see, but very little to do.

Given that what separates games from other art forms is interactivity, between the player and systems, and between the systems themselves, it seems self-defeating to create a game that embodies neither interaction.

Dear Esther was a deliberate attempt to create a first-person game that didn't focus on guns. The intent is admirable, but I think there's a reason why nearly all first-person games are shooters, and it has little to do with the misguided notion that gaming is fixated on violence. It's simply because guns are simple, yet versatile, tools to possess in a virtual world.

Alongside their intended function as weapons, guns also let the player interact with objects at both short and long distances. They allow you to shoot buttons and levers as well

as enemies, opening new pathways to progression in the game. Guns give level designers freedom to build complex puzzles and environments out of a very basic yet universal mechanic. With a gun, every click of the mouse lets the player reach into the screen.

For me, taking guns from a first-person game is like removing the wheels from a car. If you don't replace them with something else, you won't go anywhere. TheChineseRoom's games attempt to replace guns with story and narrative, but I don't find it much fun being *told* a story in a virtual world. A game

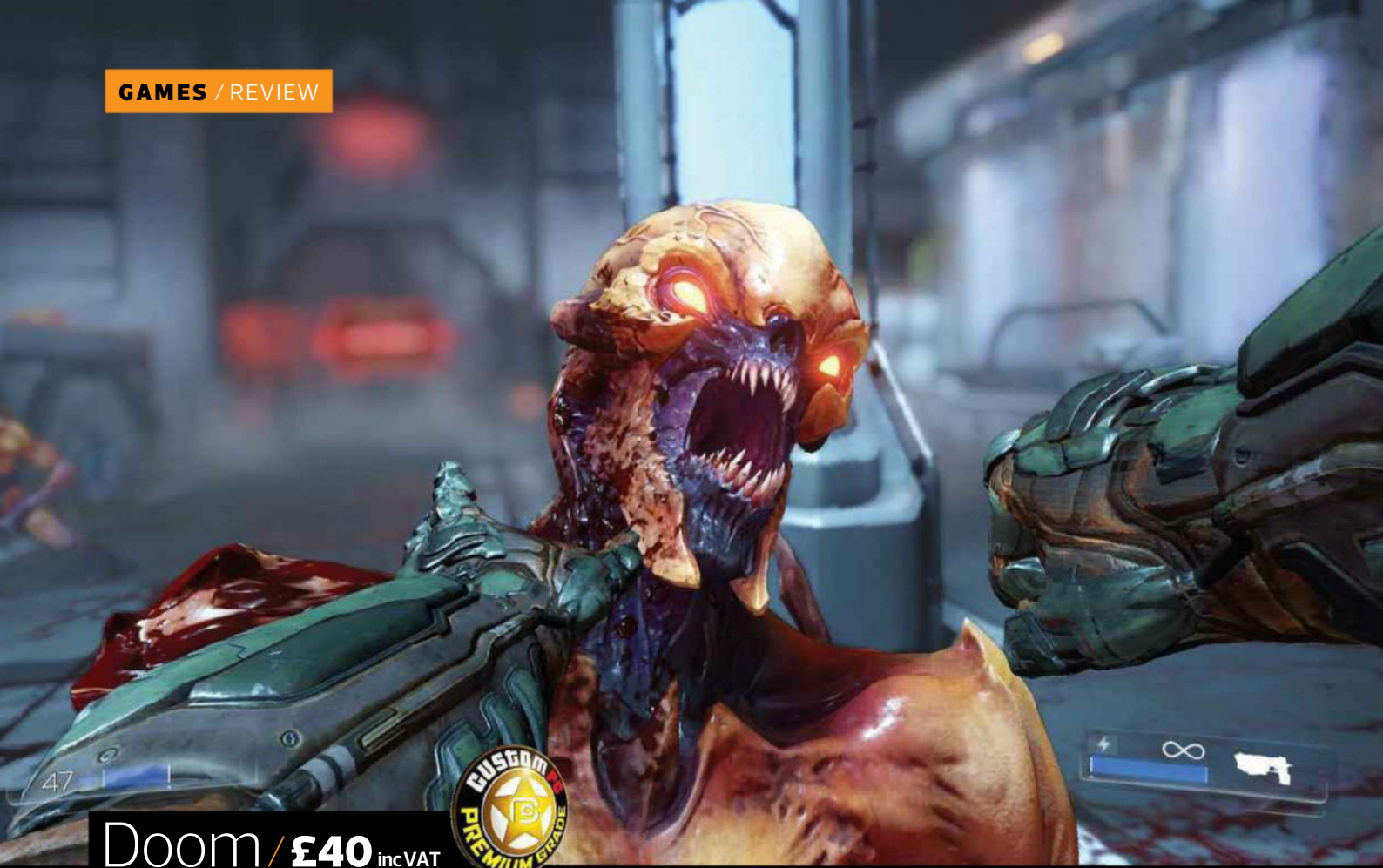
needs to involve the player directly; otherwise it's like standing on a stage while the actors play their parts, making you feel alienated and uncomfortable. Puzzles are another option, but they offer individual interactions rather than moment-to-moment play.

One of the most interesting attempts to create a non-violent first-person game was *Firewatch*. Like Dear Esther, it was narrative-

focused, but it made its story interactive by letting you chat about what you encountered and discovered in the game world with a co-worker over the radio, selecting different dialogue responses depending on how you felt about the situation. It involved the player in the plot both narratively and mechanically.

Future first-person adventures need to come up with other such ideas if they're to become worthy of that title. They need to make their mysteries and adventures interactive, rather than distracting the player with attractive surroundings as the game warbles dialogue into their ears. It certainly won't be easy, but that's nearly always true when seeking a non-violent solution. When it succeeds, however, the result will be infinitely more satisfying. **SPB**

Guns are extremely simple yet versatile tools to possess in a virtual world



Doom / £40 inc VAT



DEVELOPER id-tech/ PUBLISHER Bethesda/ WEBSITE <http://doom.com>



You can always tell the quality of a Doom game by the number of naughty giggles it elicits. The original game still causes a cackle when you carve open an imp's chest with a well-placed blast from the rocket launcher, while 2004's Doom 3 is barely capable of stirring a grin with its plodding pace and peashooter weapons. It took all of five minutes for 2016's Doom to have us honking with laughter, when we attacked a stunned imp from a high ledge, which caused our green-suited marine to pin it to the ground and stamp its skull into mush.

This latest reboot of the 1993 classic frames itself as 'going back to the roots' of the original game, and it certainly feels more like the original games than Doom 3's lumbering survival horror. Primarily, the new Doom takes our rose-tinted nostalgia of how it felt to play Doom 23 years ago, and renders it incarnate. It's a relentless, lightning-fast, furiously loud celebration of guns, gibbs and Glory Kills. But most importantly, it's a huge amount of fun.

The story is, basically, that there are demons that need to be killed. There's a little more to it, although mercifully not much. UAC director Samuel Hayden has been attempting to harness Hell Energy on Mars to solve Earth's energy crisis. Yet somehow this perfectly reasonable and entirely safe scientific endeavour has gone catastrophically wrong. You awake amid the disaster, chained to an altar and surrounded by possessed former UAC staff, and resolve to end the crisis by punching and shooting it in its demonic face.

Id has clearly learned from many of the mistakes it made with Doom 3. To start, narrative storytelling is kept to a minimum. There are a couple of dialogue sequences which go on for too long, and your Codex is

absolutely stuffed with ludicrously detailed Doom lore that you should avoid like a snog from a Mancubus, but for the most part, you're left to your own devices to do what DoomGuy does best – eviscerate demons with big guns.

And oh boy, do you get to kill some demons with some big guns. Doom's combat is absolutely brilliant. Your character glides across levels like a weaponised eagle, able to leap across large gaps and mantle speedily onto platforms. However, your enemies are equally lively. Imps scramble nimbly away from your gunsights, springing off walls and lobbing fireballs underarm as they dart across your vision. The previously slow and clumsy Hellknights also now attack with the speed and power of a rampaging bull, able to leap great distances and damage you with a powerful ground-pound. The game generally looks fantastic, but the importance of the work done by id's animation team can't be understated.

Combat always takes place in arena-like areas, some of which are cleverly disguised as Foundries or science labs, while others dispense with any pretence and include jump-pads, teleporters and devastating powerups. Enemies always attack in numbers, and even a lowly imp can quickly slaughter you if you stand still. The secret to success in Doom is to never stop moving, never stop shooting and, most importantly of all, never stop killing.

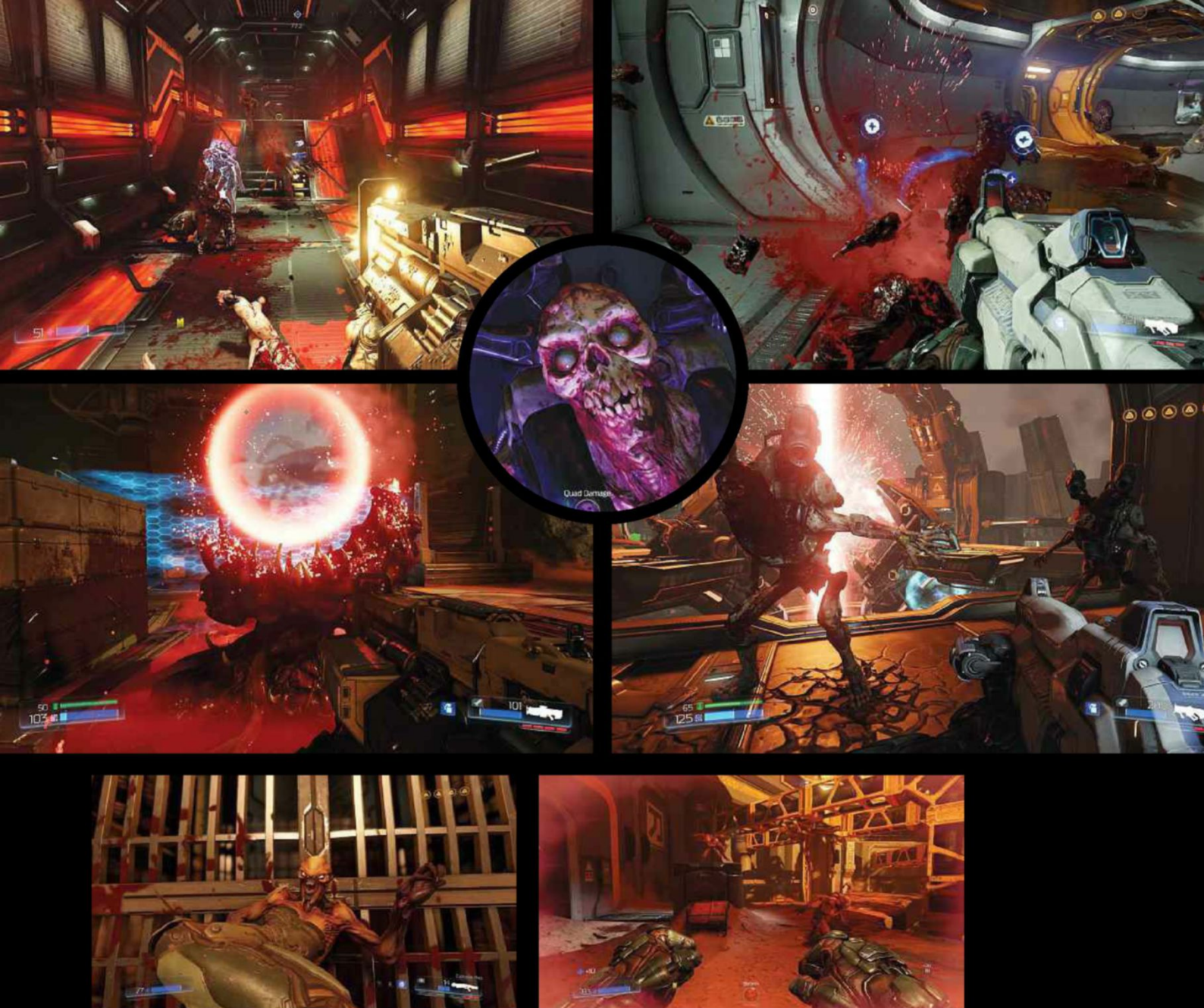
There's a compulsive rhythm to Doom's combat. Most weapons will obliterate an enemy at close range, but they're more likely to stun them from mid-distance. A stun leaves them open to a Glory Kill – a messy hand-to-hand execution which guarantees a drop in health for your demonic victim. When your guns run dry, it's time to bring out the chainsaw; dispatching an opponent with your

OVERALL SCORE

88%

/ VERDICT

Big, brash and breathless, Doom makes the single-player FPS great again.



petrol-powered blade causes their insides to shower out ammo like an NRA vending machine, enabling you to get straight back into the fight.

The weapon roster is gloriously fun too, benefitting from some modern conventions. There's no reloading, but all guns can be modded with two alternate fire modes. The shotgun, for example, comes with an explosive-shell secondary fire mode, while the heavy machinegun is capable of firing a barrage of micro-missiles. Meanwhile, the secondary modes of the chain gun and newly introduced gauss cannon are so powerful that they can take out the toughest enemies in one or two shots. However, they also slow you down when they're fired, leaving you dangerously vulnerable for a couple of seconds.

Doom's single-player campaign is a beautiful ten-hour ballet of bullets and violence; it's slick, potent and utterly electric. That said, it isn't without problems. While the environment design is ideally designed for fighting and enjoyable to explore in terms of rooting out secrets, aesthetically, both the UAC facility and Hell are drab and lack variety. Also, while Doom does a splendid job of refreshing the familiar guns and enemies, it fails to add enough that's new. Indeed, the game runs out of ideas two-thirds of the way through, when the gunplay begins to wear thin.

Given the overall quality of the single-player campaign, such flaws are forgivable. A greater issue is the multiplayer mode, which struggles to bring anything fresh. The staid environment design is more noticeable here, and the maps lack any sense of character or individuality, which makes them trickier to memorise. The absence of a soundtrack and the fact that you're fighting other DoomGuys only adds to the banality. It sports a couple of new ideas, such as the ability for players to temporarily transform into powerful demons, but it lacks the charm of Quake III or Unreal Tournament, or the scope of Battlefield.

Doom's multiplayer longevity will likely reside in the SnapMap mode, which allows players to create and share their own maps, missions and campaigns. They can be played either solo, cooperatively or competitively. Jumping into a new map is impressively quick, and there are already a few superb attempts at mapmaking, including a remake of E1M2 and a map called Harvest Doom, which basically turns Doom into Minecraft.

However, Doom has always been primarily about the single-player experience, which it has nailed this time. It doesn't do quite enough to be a classic, but it remains a pulse-pounding revival of the game that started it all.

RICK LANE

The Banner Saga 2 / £14.99 inc VAT

DEVELOPER Stoic / PUBLISHER Versus Evil / WEBSITE toicstudio.com

The Banner Saga 2 directly continues the story that ended abruptly in the original game. Retaining the same colourful art style, evocative writing and gut-wrenching decision making, the sequel improves the combat and carries over the consequences of choices made in that initial act.

The sequel kicks off in the aftermath of the climactic battle of The Banner Saga, framing its story around one of two possible main characters, depending on which of them survived the fighting. From there, your crimson-bannered caravan continues its arduous journey to the city of Abberrang, where the human clans and towering Varl gather for a final stand against the endless waves of statue-like Dredge pouring down from the North.

As with the previous game, Stoic's ability to tell a compelling story is the main draw. Although the core plot remains the same regardless of which character you play, the entire tone of the journey is different depending on who leads the caravan, right down to the orchestral score that accompanies your clan's onward trudge through snow and mud.

Moreover, the sequel adds a second strand to its narrative in the form of Boeverk, the giant Varl captain



of mercenary band The Ravens. Boeverk is aggression incarnate, a wall of barely contained muscle and rage. He makes for a splendid secondary story, allowing the player to indulge in some of the nastier dialogue choices in a way that's consistent with the character. However, Boeverk can also be played in a friendlier manner in a fashion that still makes sense, which is a brilliant bit of characterisation on the developer's part.

Meanwhile, the writing remains excellent, the decision making tough and the consequences uncompromising. The only downside is that the story is still told through static screens with no voice acting. That's a shame, because the

OVERALL SCORE

77%

/ VERDICT

Although the combat system is lacking, The Banner Saga 2's excellent storytelling makes it worth the relatively inexpensive entry fee.

Everybody's Gone to the Rapture / £16 inc VAT

DEVELOPER TheChineseRoom / PUBLISHER PlayStation Mobile, Inc / WEBSITE www.thechineseroom.co.uk

A year after launching as a PlayStation 4 exclusive, TheChineseRoom's spiritual mystery set in the quaint British countryside has finally arrived on the PC. Set in 1984, Rapture takes place in and around Yaughton, a fictional Shropshire hamlet that epitomises rural England. It's quiet, pleasant, surrounded by idyllic countryside and ever so slightly xenophobic. There's just one problem with Yaughton (aside from the xenophobia) – everybody has disappeared, and it's your job as unnamed first-person protagonist to figure out what's happened.

It's easily one of the most beautiful games you will play on your PC this year. The rendering of rural England is an astounding achievement, from the undeniably British road signs catching the summer sunlight, to the whitewashed pub with hanging baskets out front and a beer garden out back. Any English person will find this place familiar, and some of its virtual vistas are breathtaking.

This incredible environment is the setting for the simultaneously grand and quaint story. It's a tale of everyday life torn asunder by a slow burning apocalypse.

OVERALL SCORE

57%

/ VERDICT

Although it has exceptional production values, Everybody's Gone to the Rapture is hollow at the core.





smattering of animation in the game is superb. If the entire game were like that, it would be on another level.

Combat has been expanded considerably too. New units such as centaur-like skirmishers allow for greater tactical variety, and the entire system is much better explained this time. A new training and challenge system communicates formations effectively and demonstrates how to perform powerful combos. Unfortunately, battles are still the weaker

element of the game, though, failing to convey the sense of scale and drama that the epic narrative describes.

Nevertheless, *The Banner Saga 2* is a worthy sequel, continuing an engrossing tale and making small but welcome alterations to the base systems. It doesn't quite live up to its full potential, but the great storytelling makes it worth the cheap price.

RICK LANE

Although there's nobody left in the village, echoes of their lives have been left behind in the form of luminescent, ghost-like figures.

Both the writing and acting are on a par with the visual design; conversations are snappy and natural, and it's wonderful to hear such a range of British dialects in a game. The representation of small village life is convincing too, if rather stereotypical, with a daily routine of community hall meetings, petty family arguments, visits from the reverend and crisscrossing infidelity.

After a general introduction, each new area you visit focuses on a particular character from the village. The thrust of the tale, however, revolves around Stephen Appleton, a professor recently returned from the USA with his wife, and a bit of a pariah. He seems to know most about what's

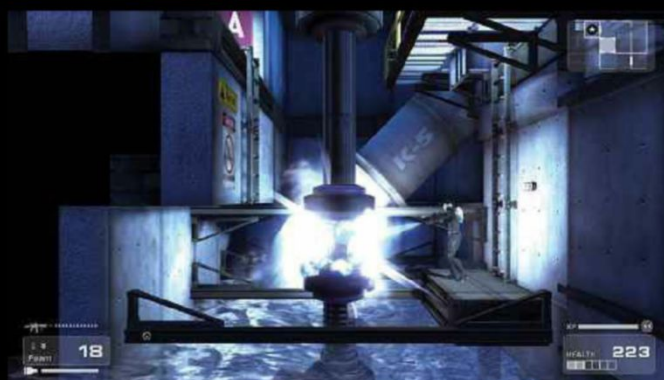
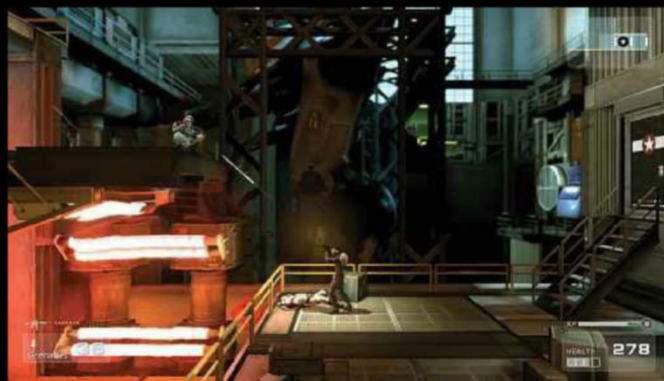
happening in the town, and will resort to extreme measures to prevent the situation from worsening.

Unfortunately, *Rapture* is let down by minimal interaction with the game world – you can basically open some doors and activate a few radios. Even a football in a garden is rooted to the ground like a boulder; your involvement is entirely passive. A simple action such as running is rendered torturous by the deliberately sluggish controls.

If you're looking for a peaceful way to while away a few hours, then you could do worse than *Everybody's Gone to the Rapture*. However, first-person adventuring has moved on from wandering around a pretty but empty environment while the game talks at you, and *Rapture* ends up feeling stuck in the past in more ways than one.

RICK LANE





Shadow Complex Remastered / £11 inc VAT

DEVELOPER Chair / PUBLISHER Epic / WEBSITE www.epicgames.com/shadowcomplex



One of Unreal Engine 3's flagship games, Shadow Complex was originally released in 2008, and this remastered edition sees the riotously entertaining 2.5D shooter hit Steam for the first time. Shadow Complex has a silly premise that conceals a much smarter mechanical brain. It casts you as lantern-jawed American Jason Fleming who, while hiking with his girlfriend, accidentally stumbles upon the secret base of a paramilitary organisation intent on conquering the globe. When his girlfriend is kidnapped, he tries to rescue her by blowing up almost every inch of the base.

You explore different pathways of a semi-open map, unlocking new areas as you acquire more powerful weapons and equipment. While initially the game feels underwhelming – the starting pistol is little more than a peashooter – it soon ups the ante with a range of powerful and inventive items. A particular standout is the Foam Gun, which entraps enemies in an expanding gloop and doubles the power of any explosive fired into it. The proves of navigating the environment is equally creative thanks to your rocket pack, which lets you double jump and shoot up ladders, and a later upgrade that lets you power-sprint through almost any obstacle.

However, what makes Shadow Complex such a joy is the way it apes the tone of daft action movies. Enemy death animations are deliberately overdone, with

guards flinging themselves away from grenades just before they explode, and tumbling over railings screaming as they plummet to their demise. Boss battles against helicopters, giant robot spiders and hulking mechs always culminate in a gigantic explosion once the opponent is destroyed. During turret sections, the game switches to a third-person view and throws every kind of enemy imaginable at you.

The environment design is also surprising and playful. The Complex is stuffed with secret upgrades that urge you to explore, and although the game often necessitates you to backtrack through environments, it does so in inventive ways. One boss battle requires you to destroy several water pipes and flood the room, for example, but doing so immerses an entire section of the base, so instead of running back through the same area, you swim through a completely changed environment.

Shadow Complex is full of similarly ingenious little ideas, always seeking a way to make the action a little more fun. That said, although the story is clearly parodying daft action movie plots, at times the writing is too cringeworthy to be funny.

The remaster also isn't that impressive. Although it looks fine, in both visuals and controls, it has a distinctly last-gen feel. Nevertheless, Shadow Complex is a splendid 2.5D shooter, and its arrival on PC is more than welcome.

RICK LANE



OVERALL SCORE

80%

VERDICT

Silly, inventive and above all fun, Shadow Complex Remastered is a welcome update of a classic.



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RICK LANE / THE ENGINE ROOM

Twine

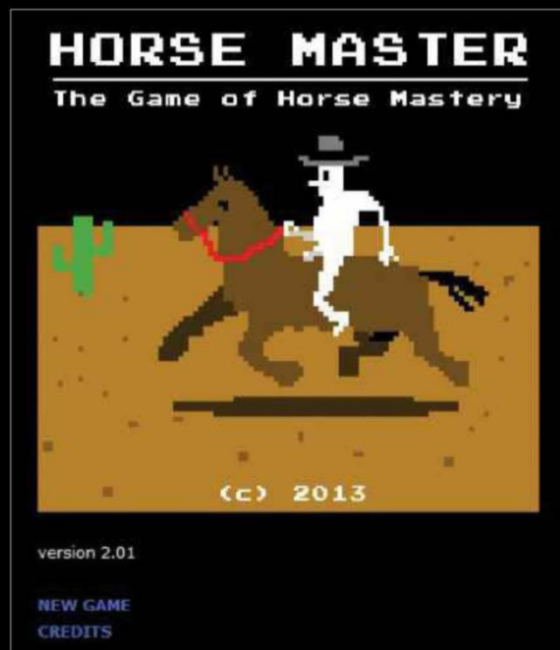
Rick Lane speaks to Chris Klimas, creator of the world's most accessible game development software

Accessibility is a growing priority for modern game development software. Toolkits such as Game Maker are built to appeal to users without a background in computer programming, while Unity has long been designed with the idea of building a powerful, all-purpose engine that's relatively easy to learn. Even the mighty Unreal Engine promoted accessibility in its fourth iteration; its 'blueprints' scripting system was designed to visualise the coding process, minimising the need for coding knowledge. However, even these examples' accessibility efforts pale in comparison to the elegant simplicity of Twine, which requires absolutely no programming knowledge whatsoever.

Twine is a tool specifically designed for creating interactive fiction. Through its simple graphical interface, users can create complex stories with branching narratives. It was created by Chris Klimas in 2009, while he was still at college.

'I had been working with interactive fiction such as text adventures for quite a long time, and I'd always felt a little frustrated with the parser interface – the part where you have to type in stuff,' Klimas says. 'It was difficult to try to tell the stories that I wanted.'

In search of a better alternative, Klimas stumbled upon a program called TiddlyWiki, which he describes as 'a web page that's actually self-modifiable – it's very strange. It doesn't work anymore because of security restrictions, but you could hit "save" on a web page and all of a sudden, it would save itself. It was crazy, without any backend.'



Horse Master is ostensibly about rearing a horse, but it's really a puzzle game about interpreting the story's strange lexicon

The JavaScript version of Twine enables users to write stories in a web browser

Klimas began experimenting with TiddlyWiki as a way to produce branching fiction, but found it to be less useful for this purpose than he anticipated. 'It was a little like trying to design a maze while you were inside it. On one level, it's great; on the other, it can get really confusing very quickly, so I started thinking about ways in which I could build something that would help me work with these links and so on – that was really the genesis of Twine.'

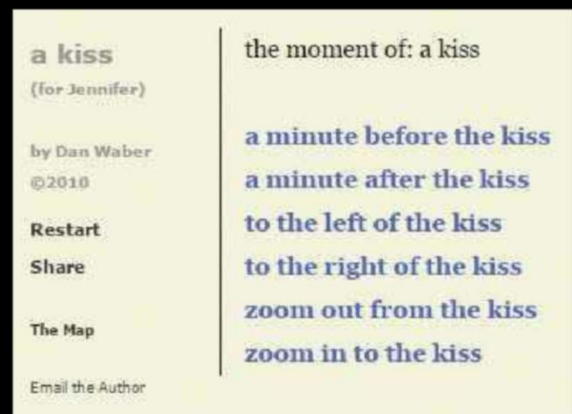
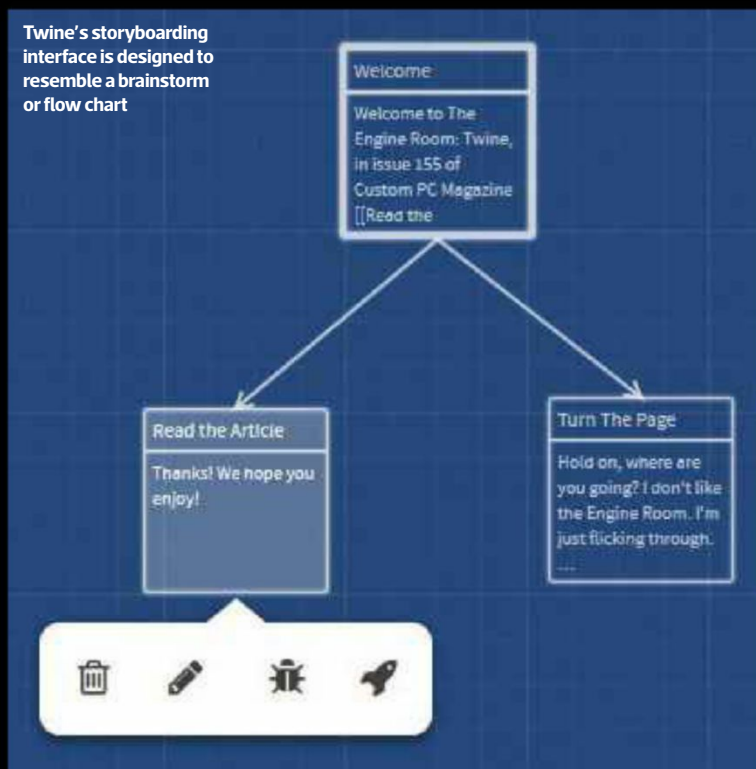
Twine simply connects different passages of a story together in the form of hyperlinks. From a node

that's titled 'Start', its visual interface represents each new passage in a box, and the connections to these passages are represented with arrows. This format gives the developer a clear overview of their story at a glance, with the ability to change and manipulate the content and connections of their story without using manual programming. 'It was very much a case of trying to observe how other people had approached the issue, and how would I go about doing it if I just had a piece of paper and wanted to chart something out – what would feel logical and intuitive to people?' Klimas says.

The first version of Twine was coded in Python, simply because Klimas was familiar with Python and it supported a range of platforms. It took him approximately six months, a fairly brief turnaround in software development terms, although there were multiple false starts during this process.

The initial version of Twine, which was called Twee, had storytellers typing directly into a command line. Klimas states that it worked fine, but nobody seemed particularly interested in it. He then developed a web app that performed the command compilation for the developer, but that didn't take off either. 'The essential issue is that there are a certain number of concepts that you need to understand – what is a compiler? What is source code? What are directory structures, and all these concepts that most developers would take for granted,' Klimas says. 'But for people who are fresh to game development – writers or whatever – they don't know any of this stuff, and





Despite its massive structural complexity, *A Kiss* is presented with elegant simplicity

source project', Klimas points out.

Eventually, Klimas returned to Twine and, working together with the more dedicated users, launched the second version last year. Twine 2 included several major changes. It's coded in JavaScript and web-based, which makes it much more viable for using on Linux and tablets, and writers no longer have to name the start of their story 'Start'. After having a little distance from it, I thought: "This is silly, it should be easier to work with," Klimas says.

What's more, Twine development is continuing apace. The internals of the program have been gradually reworked, including implementation of the JavaScript library React. 'I was talking on the Twine forums and people were asking, "Why didn't you use React," which is a very popular library in JavaScript for user interfaces, and I said, "Well, React didn't exist back then,"' Klimas laughs. He's also planning to enable the addition of multimedia, and collapse the story map into multiple levels of boxes.

It's all a continuation of Klimas' aim to make Twine as accessible as possible. Klimas strongly believes in this ethos, and it goes beyond ease of use. Twine is and always has been open source, because Klimas wants people to download and use it with no barriers to entry.

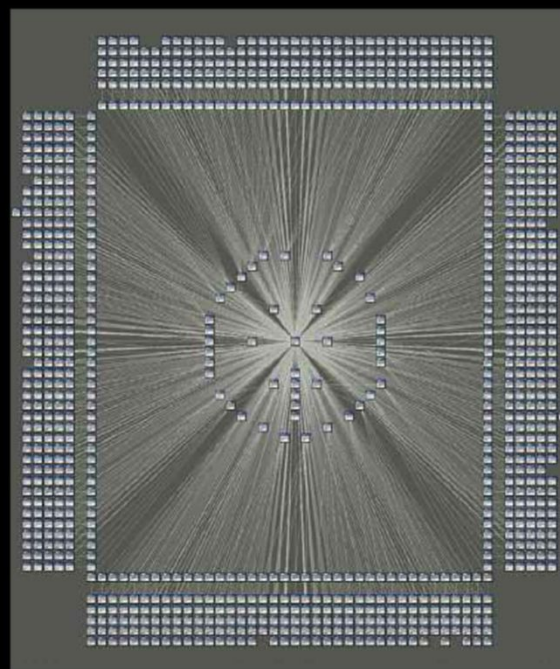
'I personally believe that most tools to create things, at least in some shape or form, ought to be free,' Klimas says. 'I'm certainly not trying to say that commercial software is bad – I've sold games that I've made, or put them up for sale. It definitely has its place. I think it's also true that open source is really a force for good.' **OPB**

the expectation is, correctly, that you shouldn't have to learn these kinds of details.'

Eventually, Klimas settled on a graphical interface with which a developer could interact. It was more complex to create, and Klimas states he spent a lot of time optimising it so that it didn't screech to a halt when running larger stories with lots of nodes, but it undoubtedly paid off in the long run.

Although Twine requires no coding to design a basic story, you can employ a few simple commands to create far more complex narratives, using variables to keep track of items in your story, such as coins the character picks up or other objects in the game world. Some of the stories are incredibly ambitious. One of Klimas' favourite examples is called *Horse Master*, an eerie mystery game about rearing a horse. 'But it's not like a normal horse. It's not like the real world, so there are all these mysterious statistics. You're not sure what they actually do, but the character knows.'

Use of Twine initially grew slowly, but through the works of writer/designers such as Anna Anthropy and Dan Cox, its popularity has skyrocketed over the years. The Washington DC Shakespeare



company recently built a Twine game based on its production of 1984, and Twine was even referenced in the irreverent children's TV show *Adventure Time*. In fact, Twine became so popular that Klimas found simply supporting it was overwhelming, and he stopped for a time, leaving the software to be supported by a loose group of committed users. 'It's very exhausting to shepherd an open

The story map for *A Kiss* by Dan Waber, which forced Klimas to rethink how Twine was optimised



WHAT YOU NEED TO PLAY

Ben Hardwidge runs a load of different GPUs on ID's latest demon stomper, and tweaks its settings, to find what you need to run it

The original Doom was remarkable for many reasons – its killer soundtrack, the detailed graphics and the sheer terror of a demon suddenly appearing in a darkened corridor. What's often overlooked, though, is that Doom ran on nearly everything. If you were prepared to drop the detail settings, you could (just about) run it on a 16MHz 386, or you could run it at full pelt on a 66MHz 486 DX2. You could even run it on a SNES, with a Super FX-assisted cartridge, as well as the first PlayStation, the Atari Jaguar and even an Acorn Archimedes. Doom offered groundbreaking tech, but Carmack and co also clearly wanted as many people as possible to be able to play it.



There seems to be a similar attitude with the latest instalment of the hellish shooter. It isn't available for any last-gen consoles at launch, but its PC system requirements are surprisingly lenient. The official system requirements list a minimum spec of a Core i5-2400 with a GeForce GTX 670—not exactly cutting-edge hardware.

What's more, as we'll come to later, you don't lose an awful lot by dropping the settings a little.

You can customise a lot of advanced settings, but you're unlikely to find any really advanced tweaking necessary—the four main presets (Low, Medium, High and Ultra) pretty much cover all the bases. Before you start, don't panic if the introductory video logos grind your system to a halt—the game did the same on several systems when we first ran it, and the intro logos and videos run perfectly after a restart.

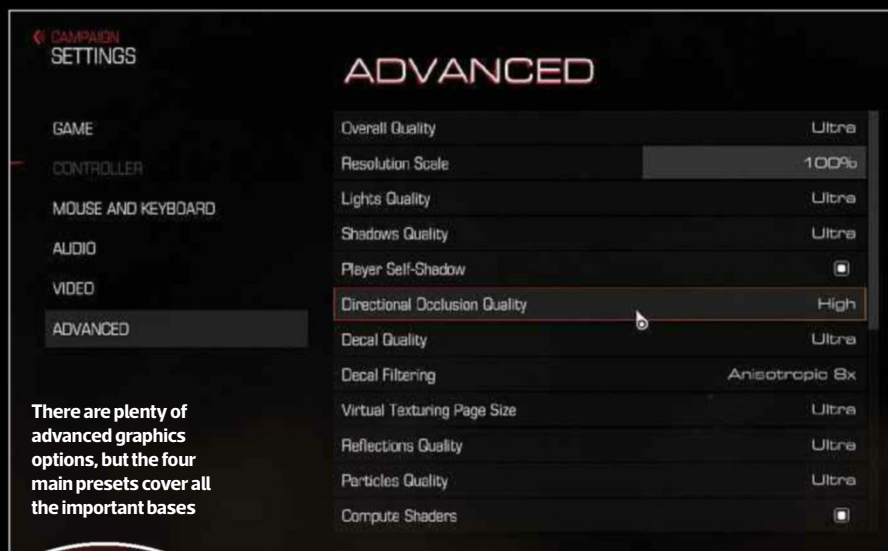
OUR BENCHMARK

Unlike many previous ID games, Doom doesn't have a built-in time demo benchmark, which meant we had to create our own reliable, repeatable test. What's more, as Doom's savegame system relies on checkpoints, rather than separate save files, and you can only have one checkpoint at a time, we needed a benchmark near the beginning of the game, just in case we lost our checkpoint. We also needed to keep combat carefully controlled to make the test repeatable.

We settled for a test that begins in the first UAC level. Once you're out of your bods, you've shot your first round of demons and you've picked up the shotgun, the game marks a checkpoint at the bottom of the stairs, which is where our benchmark begins and we start a 60-second FRAPS timer.

We go up the stairs, open the door, wait for a big demon to do his usual camera-mugging display-snarl and then shoot him with the shotgun. We then go through the corridor on the left, and carry on until we get to the end. We then go down the stairs, turn around to look at the demons in the middle of the room, look left, go up the stairs, turn right and walk to the end of the room, where we turn around again to look at the enemies in the middle. We repeat this circuit of the room three times, stopping to look at the enemies in the middle at each end, at which point the 60-second timer ends.

To keep it repeatable, the only combat is with the big demon at the beginning, but



This guy gets pumped full of shotgun in the name of assessing frame rates

stopping to look at the enemies halfway around each circuit means we get plenty of animated characters in the demo, and we also get an idea of the smoothness of general gameplay as you navigate rooms and corridors.

There may well be parts of the game that are more challenging for your graphics hardware, with outdoor environments and more enemies, but this test gives a good general idea.

We run each test three times, and report the average, rejecting and rerunning any results that are significantly different from the others.

ULTRA SETTINGS

We kicked off testing with the game's Ultra preset, which sets all the settings to Ultra, if it's an available option, and also enables 8x anisotropic filtering and 8TX TAA. By default, the game is capped at 60fps, but you can open the door to higher frame rates by disabling v-sync.

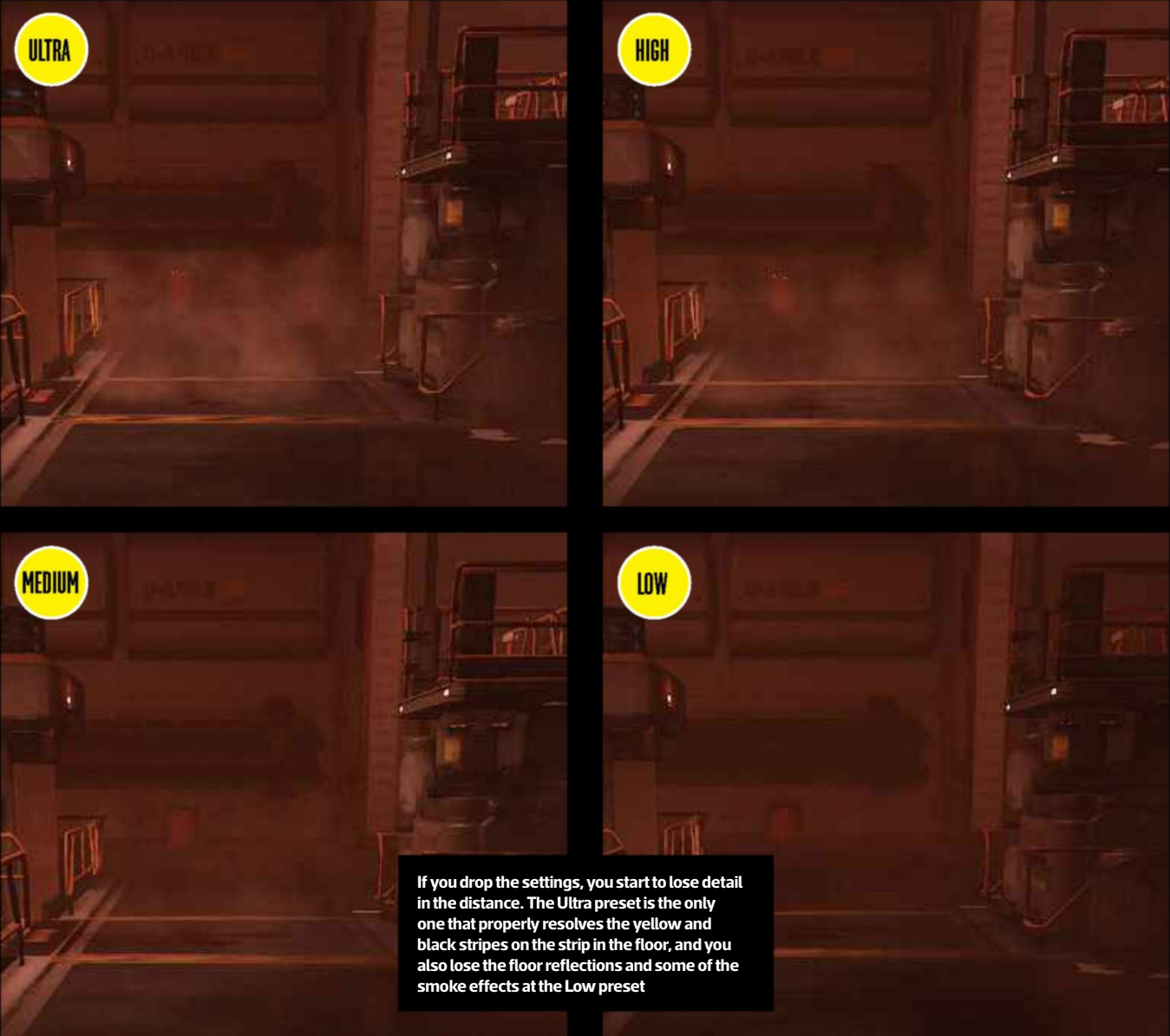
Even at Ultra settings, though, Doom is remarkably forgiving. At 1080p, our GeForce

GTX 970 card never dropped below 79fps, and our GeForce GTX 960 2GB was quite happy staying above 30fps, while AMD's Radeon R9 380 and 380X cards were comfortably above 40fps (sadly, we weren't able to get hold of any Radeon R9 390 or 390X cards for testing this month).

The only GPU on test that couldn't cope with these settings was the AMD R7 370, with a stutter minimum of 21fps, and the GeForce GTX 950 was only borderline playable, dropping down to 28fps.

We then upped the resolution to 2,560 x 1,440, which saw the GeForce GTX 960 2GB drop off the playable spectrum, though AMD's Radeon R9 380X still impressively stayed above 30fps at this setting, and the GeForce GTX 970 remained strong at this resolution too.

Finally, we ran the game at 3,840 x 2,160 (4K) with all the bells and whistles enabled, which saw the mid-range GPUs drop out. The GeForce GTX 970 is just about playable at this setting, but ideally, you want at least a GeForce GTX 980 or a Radeon R9 Fury card for this resolution or, even better, a GeForce GTX 1080.



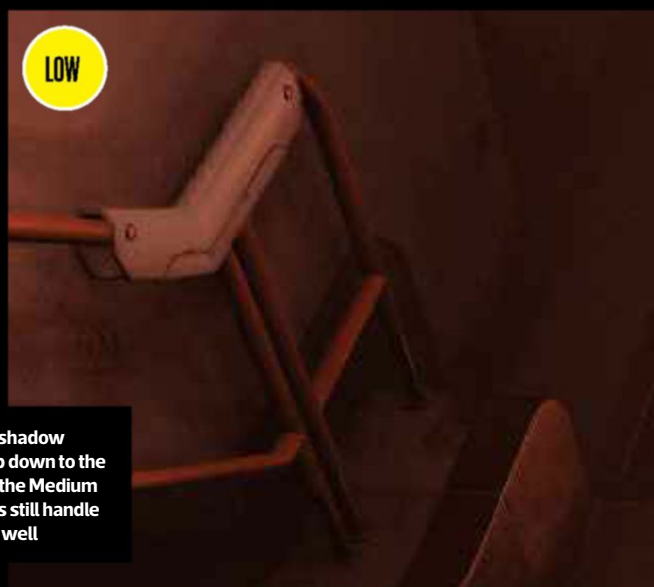
DROPPING THE SETTINGS

As Doom is already playable on a lot of hardware on Ultra settings, we were interested to see the difference made by dropping the detail presets. Each preset drops the various settings to High, Medium and Low, and also adjusts features such as anti-aliasing and anisotropic filtering. At High you get 4x AA, at Medium you get 2x AA, and at Low you only get trilinear filtering. The biggest difference is seen at the Low setting, where the shadows are less vivid, the quality of reflections on the floor deteriorates and you lose detail in the distance. That said, Doom’s Low setting still looks surprisingly good. Also, if you follow the game’s gamma setting instructions at the beginning, Doom is very dark (and orange-tinted), in order to accentuate the scares, which makes the differences between detail

settings even harder to see, with the exception of shadows. We’ve turned up the gamma in our screenshots to show the differences more clearly. In the stair rail screenshots, you can see that you lose the decent shadows on the wall at the Low preset. We also show screenshots that zoom into the distance. You can see that the Ultra preset is the only one that properly resolves the yellow and black stripes on the floor once you get into the distance, and you also lose the floor reflections and

some of the smoke effects at the Low preset. The differences are small though – you could still enjoy a game of Doom without using the Ultra preset, and it will make the game playable on weaker hardware. Dropping the game to High made it playable on a Radeon R7 370, and raised the GTX 950’s minimum frame rate to 44fps. We haven’t tried running Doom on a Core i5-2400 with a GeForce GTX 670 but, based on our testing, such a system could probably cope with it. **BEN HARDWIDGE**

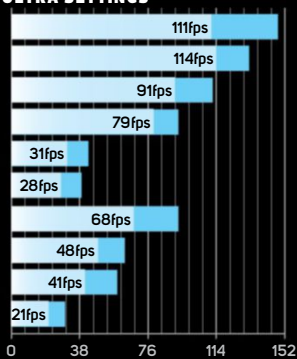
WHAT GPU DO YOU NEED TO RUN DOOM?	
1,920 x 1,080, High settings	GeForce GTX 950 or Radeon R7 370
1,920 x 1,080, Ultra settings	GeForce GTX 960 or Radeon R9 380
2,560 x 1,440, Ultra settings	GeForce GTX 970 or Radeon R9 380X
3,840 x 2,160, Ultra settings	GeForce GTX 980 or Radeon R9 Fury



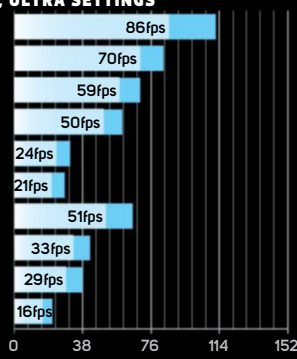
You lose a lot of shadow detail if you drop down to the Low preset, but the Medium and High presets still handle shadows pretty well

RESULTS

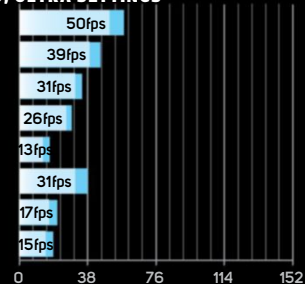
1,920 X 1,080, ULTRA SETTINGS



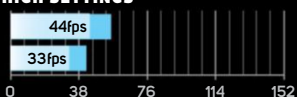
2,560 X 1,440, ULTRA SETTINGS



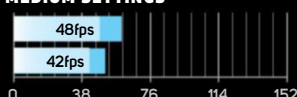
3,840 X 2,160, ULTRA SETTINGS



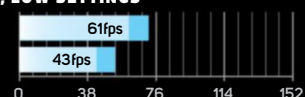
1,920 X 1,080, HIGH SETTINGS



1,920 X 1,080, MEDIUM SETTINGS



1,920 X 1,080, LOW SETTINGS



TEST KIT: Intel Core i5-3570K overclocked to 4.2GHz, 8GB of Corsair Dominator 2400MHz DDR3 memory, Asus Maximus V Extreme motherboard, 480GB SanDisk Extreme Pro SSD, Windows 10 64-Bit Home, Nvidia 368.22 driver (368.25 for GTX 1080), AMD Crimson Edition 16.5.3 driver



The Score

The evolution of video game music

Rick Lane explores how gaming music broke out from the sound chips of the 1980s and took over concert halls around the globe

Gaming has always been driven by what we see. The very name of the medium 'video game' suggests a visual format, where players take control of actions on screens which had hitherto only allowed for passive engagement. Since its earliest days, the mainstream game industry has been dominated by the relentless push to improve on that visual satisfaction, evolving from 2D to 3D, pixels to polygons, mipmaps to normal-maps and static to real-time lighting. When new gaming hardware is revealed, it's sold to upon its ability to show you something you've never seen before.

But the experience of gaming would be much hollower without its aural counterpart, from the early bleeps and bloops of games such as *Computer Space* and *Pong*, through the Chiptune soundtracks of the 1980s and 1990s which have become the definitive sound of video games. More recently, games have followed in the footsteps of film, with action accompanied by dramatic scores written by big-name composers and recorded with a full orchestra.

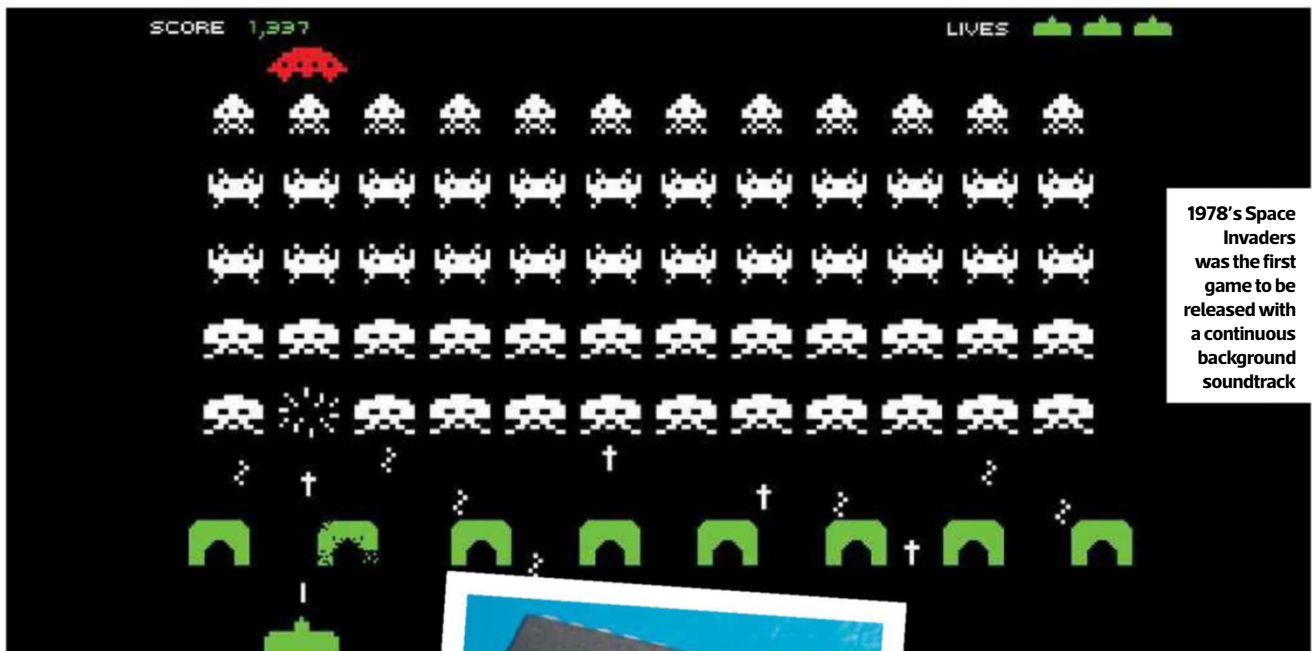
However, it isn't just the ability to represent music that's changed so dramatically since the industry's formative years. The ways in which composers work, and our notions of how music can be used in games, have radically altered as well. For some games, music isn't simply a way to enrich the game

experience, but a fundamental component in its mechanics and systems, interacting directly with the very code that makes the game function. What's more, modern tools and software enable anyone from any musical background to try their hand at composing music for games.

'The scope of what we can do nowadays has developed as much as, say, graphics capability,' says David Burrows, a freelance game composer whose work includes the comic RPG *Disposable Heroes*, and *Gun Monkeys*, a game by Size Five Games, creator of *The Swindle*. 'I can translate the

The soundtrack to *Disposable Heroes* was inspired by the chiptune soundtracks of the 1980s and early 1990s





1978's Space Invaders was the first game to be released with a continuous background soundtrack

orchestral and synth sounds that run around in my head into something tangible in a relatively short space of time from my own small studio.'

A relative newcomer to the scene, Burrows got into gaming composition as a result of what he believed to be the onset of a midlife crisis. 'My brother pointed out that my general melancholy was probably just because I wasn't doing anything creative at the time and had no outlet, so I downloaded Garage Band for my iPhone and just whittled some basic demos, which I then shared around games developer forums. Luckily for me, a couple of people stopped by long enough to take a listen and get in touch.'

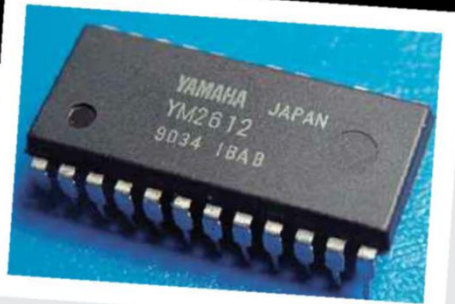
Chiptune beginnings

Burrows grew up in the 1980s, and has fond memories of the chiptune soundtracks of the early classics. 'I try to build on the ethos behind those classics in terms of making memorable title theme tunes, while creating a sound that's not only more expansive, but also has my own stamp on it somewhere along the line,' he says. 'Some of my early favourites, those classic chiptune sounds of early arcade games and the themes from iconic games through the 1990s remain wonderfully evocative.'

Chiptune was the gateway to the gaming music scene of today. The name derives from compositions written specifically for PSG sound chips, which generate sound waves through a synthesis of multiple waveforms (PSG stands for programmable sound generator). Although PSGs have been used to produce basic sound effects for as long as games have been around, the first true chiptune was the four-note descending melody that continuously played in the background of Space Invaders.

More complex tunes could be played by adding more sound chips to the hardware, as with the soundtrack to 1982's Super Locomotive. In the 1980s, FM synthesis allowed for the production of harmonic chiptunes, and their adoption was a major aspect of the switch from 8 bit to 16-bit consoles in the late 1990s.

Although a product of the limitations of computer hardware at the time, musicians' work with the PSG sound chip resulted in some genuinely timeless



The Yamaha YM2612, a PSG sound chip with six FM Channels, used in the original SEGA Mega Drive

compositions. The themes to Mario, Zelda and the introductory Green Hill Zone track to 1991's Sonic the Hedgehog are some of the most recognisable compositions in gaming history. Indeed, as testified by Burrows' own line of work, the chiptune has gone from being a necessary evil to a recognised musical genre in and of itself, perhaps the only genre of music

to emerge from an industry whose primary concern wasn't the composition of music.

The arrival of dedicated sound cards and CD-ROMs in the early 1990s massively expanded the audio potential of games.

In 1989, Creative's iconic Sound Blaster card, which started the staple audio series of PC gaming in the 1990s, combined digital 8-bit audio recording and playback with FM synthesis, while the massive data-storage capacity of CD-ROMs meant games could be developed with far more comprehensive music and sound design.

From this point onwards, the gaming industry's approach to music would only increase in ambition. Games series such as The Elder Scrolls have won multiple awards for their dedicated orchestral scores, while the likes of Grand Theft Auto and the Tony Hawk's skating games have become notable for licensing the music of massively popular bands. Nowadays, successful composers such as Hans Zimmer and Trent Reznor are writing soundtracks for games, while even small indie projects such as Subset Games' FTL have become famous for their soundtracks as much as the games themselves. 'Developers do seem to appreciate the importance of having a strong soundtrack to their game – it would always sound incomplete without it,' says Burrows.

The composing process

So what's the process for composing a soundtrack to a game? The answer is that it depends on the project. 'Chiming with the developer is the most important aspect,' says Burrows. 'Some things are straightforward, in that you can see where the developer is going and what they want to achieve from the outset, and nine times out of ten, simply from having the ability to get the right feel for these things, the answer hits you straight in the face.'

Creative's original Sound Blaster card, which paved the way for PC game music to go beyond FM synthesis





game, your team of special operatives embark upon a dangerous 'Suicide Mission' to destroy the base of a powerful group of aliens known as the Collectors. Wall's thundering score for this section slowly builds from a quiet, electronic beginning into a pulse-pounding orchestral blend of strings, brass, drums and choral vocals.

'I was on a plane travelling somewhere and this melody just revealed itself,' Wall says. 'So I took out my iPhone, sang the melody into it and later played it on the

piano and sent it to Casey Hudson (Mass Effect 2's director). He liked it and wanted to hear it orchestrated. That turned into a theme and variations that were used in the Suicide Mission.'

The Suicide Mission is the climax of Mass Effect 2, where lengthy action sequences are combined with dramatic cutscenes, and it's all highly interactive. Particular characters can even die depending on your decisions, affecting the direction and outcome of the game. Such unpredictability of player action and changeable narrative pose a significant design challenge for a composer.

'Later on, I did some serious manipulation to get it all to work correctly in the game,' Wall points out. 'There are two major branches during the End Run where I rewrote the piece to fit – then when you take off after the big jump, it's full-on Suicide Mission. Rob Blake, the audio director, had to do some serious alchemy to get all of that to work, but honestly, I think that that piece is the epitome of collaboration with the developer to make a truly great gameplay moment.'

Music as a part of the game

Mass Effect 2's Suicide Mission encapsulates this particular era of video game music – intense, powerful and affecting a cinematic style. It's a perfect summary of a medium freshly released from the financial and technical shackles of the past. Yet the technological advances of the 1980s and 1990s also revealed a potentially far more intimate relationship between video games and music, one that goes beyond the use of music as an accompanying layer, to heighten an emotional scene or intensify an action sequence. Music can infuse itself into the very mechanics of a game, or even be the systemic basis for the game itself.

The Elder Scrolls series has won multiple awards for its accompanying scores

After composing the score for Mass Effect and its sequel, Jack Wall moved on to work with Activision on the Call of Duty: Black Ops series

Certain developers will have a very clear idea of how they want the music to sound, while others will be more vague, and leave most of the creative work to the composer. 'Disposable Heroes was a particularly fun recent one in that respect, an opportunity to let myself loose in a madcap cartoon world that was first described to me as "Robin Hood Prince of Thieves, but drawn in crayon",' Burrows says.

Modern audio software such as FL Studio and FMOD enable a single composer to do a complete treatment for a small-scale indie project. Larger games tend to be more demanding on the musical front, so the studio will hire a composer for the duration of the project.

Storytelling through music

Jack Wall is a veteran gaming composer who has worked with studios such as Activision on Call of Duty, and BioWare on the Mass Effect series. Wall believes that music is a fundamental part of storytelling in games. 'I think that video games as a medium is becoming more about good storytelling while letting the player be the protagonist. I really enjoy being the person that can elegantly and purposefully help to tell that story without even being noticed,' he says.

The games on which Wall works tend to be highly story-driven experiences with dramatic plots and bombastic action. Consequently, he prefers to work with the developer as the story is written, and tie his music closely to the narrative. 'Hopefully, I'm brought on as early as possible. It takes me some time to steep in the story and vibe. Initially, the developer and I have some conversations about the story and what they see the music doing for their vision of it,' Wall explains.

'I also like to fully understand the overall story arc. Where you've been prior and where you're going afterwards; where it begins, what's going on in the middle and where it will ultimately end – the three-act play. Before I write any music, I'll mess with a few themes that may get used throughout the game. If I come up with something that resonates with the team, that's usually a good point to begin to write some music.'

As with mainstream game development, composing for a big-budget game is a long-term, iterative process, during which you'll liaise with a large number of people who can influence the game's direction. 'I've heard many audio directors over the years ask, "Can you make that bigger?" In games, you need the big cues for combat sequences and action, making the player feel like they're kicking ass,' Wall says. 'That's completely important and I enjoy coming up with new and better ways of kicking ass musically.'

One of Wall's finest examples of musical ass-kicking comes from the sci-fi RPG Mass Effect 2. At the end of the





Mass Effect's musical score blends ambient electronica with cinematic orchestral movements

There have been various experiments with music-based games over the years, from games built out of waveform visualisers, such as Vib Ribbon and Audiosurf, to rhythm action games such as PaRappa the Rapper and Guitar Hero.

But more recent examples go even further, blending bespoke compositions with game systems to create unique sensory experiences.

One example is Proteus, the 2012 walking simulator designed by Ed Key and composed by David Kanaga. It's a simple game about exploring a procedurally generated island. However, what separates it from other, similar walking simulators is that each plant, animal, season and weather type on the island is bound to a specific musical motif. Rain plinks like the strikes of a piano key as you wander through it; a frog's hop sounds like someone hitting a xylophone; summer is bright and upbeat; and autumn is melancholy and faltering. Essentially, you build the game's soundtrack yourself as you explore the environment.

'I'd consider myself primarily an improviser, and my composition work stems from that practice,' says Kanaga. 'Sound is such a sensuous thing – it fills up the room you're in, whereas the screen is just a panel of light,' Kanaga continues. 'It has so much control over the mood, so when you start creating dynamic musical spaces, you're creating mood spaces that take on a psychological/explorative quality – it's not really about the logical thinking that drives so many games, but irrational experience instead.'

Kanaga believes that the gaming industry's tendency to ape the cinematic method of writing an accompanying 'score' to a game limits how games can work with music. 'If you think about the parallels between the two media, you see a lot of amazing things done in film music – such as Fantasia – that work because the music and images use the same time structures. It makes sense to achieve a similar effect in video games,' Kanaga explains.

Kanaga has explored this idea further in his more recent work on PANORAMIC.AL, in which players can manipulate a procedurally generated environment that's closely linked to the music – it's essentially a halfway house between a waveform visualiser and a traditional game.

The rest of the industry seems to be continuing down the established route of video game composition, but Kanaga's ideas may be filtering into modern games. As big-budget games shift from telling linear or even modular narratives, focusing instead on large open worlds and highly dynamic playgrounds, music too will have to become more modular, breaking into smaller pieces that respond to the mood of what's on the screen.

Either way, the gaming industry's musical adventure has only just begun. 'What gets me excited to write music is that games are still evolving,' Jack Wall says, while Kanaga's views are similar. 'For me, these explorations are about searching out the mysteries in our consciousness and the world, as opposed to what we already know.' **GPC**



Proteus has short musical melodies attached to different objects in its world, which layer over one another as the player moves around

Music and visuals shift dynamically around one another in PANORAMIC.AL





GARETH HALFACREE'S

Hobby tech

The latest tips, tricks and news in the world of computer hobbyism, from Raspberry Pi, Arduino and Android to retro computing

EVENT

Maker Faire UK 2016

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I'm in Newcastle for the Maker Faire UK's seventh event, and there's plenty on the schedule. While the atmosphere is, as always, hectic during the setup day on Friday, the list of attractions includes some heavy hitters you're not likely to see at the smaller Mini Maker Faires dotted around the country: Tesla coil demonstrations from Lords of Lightning, and an indoor Robot Wars-like battle arena, to name just two.

'I'd heard about the first couple of Maker Faires in Austin and the Bay Area, and we were looking for something to be the anchor event for our Science Festival, which we were running in those days,' Ian Simmons, director of science communications at the Life Science Centre in Newcastle tells me as makers and tinkerers from around the world set up shop around him.

'It looked great, so I rang up Make Media and said, "Could we do one of those," and we were the first Maker Faire to take place outside the USA.'

A chap cosplaying as a member of the Borg collective was only too happy to pose with visitors for photos

Not all the larger attractions are going smoothly, however. As I talk to Simmons, Leeds Hackspace is having a last-minute issue with its attention-grabbing giant LED cube – it doesn't work. Hours of troubleshooting follow, before someone

realises they've brought along the backup controller, which doesn't have the firmware loaded, just in time for the group to be kicked out of the Centre for the evening. Thankfully, the story ends well: the next morning, the cube is revived with a quick firmware burn, moments before the doors burst open to thousands of eager visitors.

Walking around the event on the Saturday, I'm not short of interesting projects to document. DoES Liverpool is here, naturally, with the Spaced Invaders Nerf shooting range, and Maker Space's penguin run is drawing an equal crowd. 'It's based on a toy that I always wanted as a kid, called Penguin Race, where the penguins go up some steps and down a small slide on a mountain,' explains Iain Yarnall. He's taking a break from catching the 3D-printed penguins, which occasionally topple from Alistair Macdonald's clever windscreen-wiper motor lift mechanism on their way to the top of a helter-skelter, which speeds them up in time for the RFID-based speed camera. 'I just decided to make a bigger one. I floated the idea in Tyneside, everyone started to pitch in and it started to happen – it all just escalated from there.'



The penguin run and LED cube are big, but there's a spacefaring rocket in the corner behind them

The penguin run and LED cube are big, but there's a spacefaring rocket and a test capsule in the corner behind them, the latter of which is home to a constant stream of kids clambering in and out of its small hatch and cramped interior. 'We started with the goal of trying to get a man into space on a privately built rocket,' explains Morten Bulskov, logistics lead for Copenhagen Suborbitals, leaning on the rocket his team has brought to the show. 'We fired the first rocket in 2011, and we've since been working on refining the system, and trying to find out what we need to go above 100km.'

Among the smaller attractions is a pair of companies looking to revolutionise the laser-cutting market: Just Add Sharks and Theo Lasers. The former is hoping to produce a 35W tube-based laser cutter for around £1,000, while the latter has opted for cheaper 1-5W diode lasers in a clever laser-cut wooden housing, aiming to hit a sub-£600 price point for the entry-level engraving version. 'The kids draw a rocket on a bit of paper, take a photograph of it and put it in front of the Loch Ness monster – two minutes on the laser: boomf,' Theo Lasers' Grant Macaulay explains, demonstrating the smartphone software he's put together to go with the lasers. 'Okay, so you don't get all of the functionality in one minute, but you get



Copenhagen Suborbitals' test capsule was a hit with visiting kids – and their parents!



Theo Lasers' low-cost laser-cutting machines are set to go head to head with those of rival Just Add Sharks

A giant LED cube built by Leeds Hackspace needed some last-minute TLC as the doors opened

80 per cent of the functionality in 20 per cent of the time.'

Racing around the event, I'm constantly drawn to one table or another: tech industry veteran Mike Cook sits with his animatronic skull Mulder, while Ben Pirt shows off his Mirobot open-hardware robotics kits. Plenty of hackspaces and maker workshops have brought toys, and my friend Stuart Childs menaces the staff with a last-minute glitter gun project. There was only time for a cursory

Travel and accommodation for the Maker Faire UK was kindly provided by <http://oomlout.co.uk>, a Halifax-based electronics hobby store specialising in Arduino and other open source products.



DoES Liverpool's Spaced Invaders drew a crowd, as always at these events



Maker Space's penguin run is a rare example of how design-by-committee can create something special

look at the hands-on areas, offering all sorts of activities, from a soldering workshop with Mitch Altman to a five-minute lesson in vacuum forming your own door hanger.

While there were one or two grumbles behind the scenes – in particular, regarding lack of complimentary beer at the exhibitors' evening meal, for the first time in Maker Faire UK history – there were plenty of happy faces, including mine as everyone packed up on Sunday.

INTERVIEW

Daniel Bailey's homebrew computers

There's one stand at the Maker Faire event (see p104) that I'm particularly eager to visit: York Hackspace.

While the table is dominated by the excellent Spacehack (see Issue 140, p94), I was seeking Daniel Bailey thanks to his latest passion – custom PCs. To clarify: Daniel isn't building x86 rigs with windows and lights; he's building entirely custom computers, down to the instruction set, running on a field-programmable gate array (FPGA) installed in custom-built cases.

'I made this one just as a hobby project, mostly just to prove to myself that I knew how to build a computer,' Bailey explains, gesturing towards the black box housing his first homebrew computer, the 8-bit C88. 'It's the simplest possible computer I could come up with that can do something – well, perhaps not useful, but meaningful. Then I decided to make a bigger one, and that's why I made this 32-bit one,' he adds, gesturing to a far larger device housed in a wooden box.

Like the earliest computers, the C88 and larger C3232 are very visual; their displays (LED matrices) act as an output and a view directly into the memory, while programs are entered by physically flipping bits using a series of toggle switches. 'I was inspired by the Manchester Baby, and I thought, "I could do that, but I'm not going to go for a big 32 x 32 grid straight away." I found these little 8 x 8 grids, and I thought, "Yeah, I could do that; a few switches should be fairly easy",' Bailey recalls, modestly neglecting to add that it was the first time he'd worked with FPGAs. 'It was fairly easy – and fun!'

The C3232 isn't just a scaled-up C88 – it can run code written for the C88, which is written in a machine language Bailey wrote specifically for the system; it can run code written for the Manchester Baby, the world's first stored-program computer, first activated in 1948; and it has its own custom processor core, selected using a three-way toggle switch. 'I thought, if I've got a 32 x 32 grid, I can definitely emulate the Baby, but I wanted my own CPU in there,' Bailey explains, toggling the switch absently. 'And I thought that, while I'm at it, I could have an emulation of the C88 in there, so the 32-bit one can emulate the C88. I thought I might as well – I've got space, chuck 'em all in!'

The process of entering a program into the C3232 is rather awkward at present though.



Daniel Bailey's C88 (front) and C3232 (rear) are as custom as PCs get

'It does take a long time to "toggle in" the program,' admits Bailey when discussing the process of toggling 32 memory bits 32 times. 'I did toggle in this program once, and decided I don't want to do that again!' There's a pending solution though – a modern version of punch-cards, produced on robust wood or acrylic using a laser cutter.

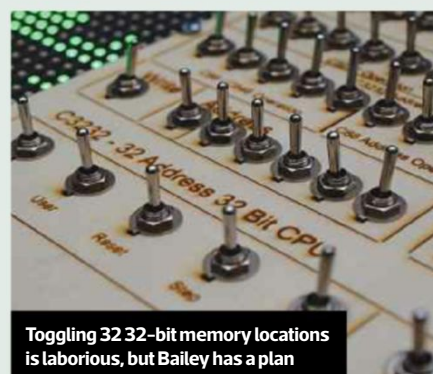
Compared with a Raspberry Pi, the systems Bailey has built are extremely

simple, but arguably more fascinating. 'The entire state of the system is visible on the screen,' Bailey explains about the Manchester Baby, which inspired the projects. 'I just thought, "That just makes things so much easier; you can see exactly what's going on." It's a great way to introduce someone to the way a computer works. For all the people who want to get right down to the lowest level, as I did when I started

The C3232 is undeniably eye-catching in its wooden housing

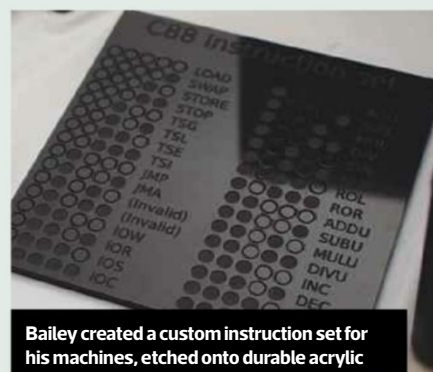


The C3232 runs a demonstrating program originally written for the Manchester Baby



Toggling 32 32-bit memory locations is laborious, but Bailey has a plan

The 8 x 8 matrix that forms the C88's display can be overlaid with clever acrylic program cards



Bailey created a custom instruction set for his machines, etched onto durable acrylic

learning programming, this sort of thing would be great, I think. I wish I'd had something like this when I started learning all this stuff!

Although both the C88 and C3232 are fully operational at the Maker Faire UK this time around, that wasn't the case when Bailey first brought a system to the event a year earlier. In 2015, a fellow York Hackspace member Bob Stone managed to fry both the Papilio FPGA board and 8 x 8 LED matrix by touching a bolt on the top of the case, an accident Bailey attributes to a static discharge caused by 'a very strange kind of flooring' in the room and that Stone recalls as his 'lightning-bolt Sith powers'.

For Bailey, designing his own hardware for implementation in an FPGA has been a great learning experience. 'Unfortunately, at the moment it's a lot harder to get into FPGAs than microcontrollers, but I certainly think it's something hobbyists should be able to do – it

means you can do things like this and do it properly,' he enthuses. 'You usually end up with something that works more efficiently than a microcontroller or another CPU. I'd love to see dev kits such as the Papilio, but even easier to use, and I think they're coming.'

More information about the C88 and C3232 can be found at Daniel Bailey's blog at <http://bitofahack.com>, and if you fancy having a go yourself, you can try out Bailey's live simulator at <http://danieljabailey.github.io/c88-js/>.

NEWS IN BRIEF

Intel Releases Genuino 101 RTOS source code

True to its word, Intel has released the source code to the real-time operating system running on the Genuino 101's Curie module. Using this code, it's theoretically possible for a sufficiently knowledgeable individual to offload tasks onto the Curie module's Quark processor, which may aid with the relatively poor floating point performance for code running on the user-accessible ARC processor.

By default, the Quark core runs the RTOS and selected radio-related tasks only, leaving user code to run exclusively on the ARC processor. The code is downloadable from <https://github.com/01org/corelibs-arduino101> now.



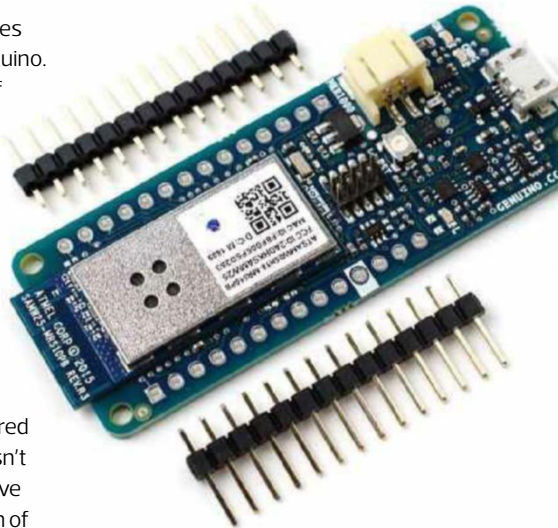
REVIEW

Genuino MKR1000

While the trademark battle rages between Arduino.cc and Arduino.org, an increasing number of devices bearing the former's new international branding, Genuino, are hitting the market – the MKR1000 is the latest one. Announced with great fanfare and a giveaway last year, the Genuino MKR1000 – known as the Arduino MKR1000 in the USA – is Arduino's answer to Wi-Fi-enabled devices such as the NodeMCU and Particle Photon. Based on an Atmel ATSAMW25 board that in turn is soldered onto a 25 x 64.6mm motherboard, it isn't exactly compact, but the designers have worked hard to make use of every inch of that space.

The board arrives in a box the size of a bulky pack of chewing gum, but without any protection: no padding, no ESD bag, not even the leaflet and stickers you'd get with an Uno or Leonardo. The headers, meanwhile, are unpopulated, with pins included in the box for you to solder into place.

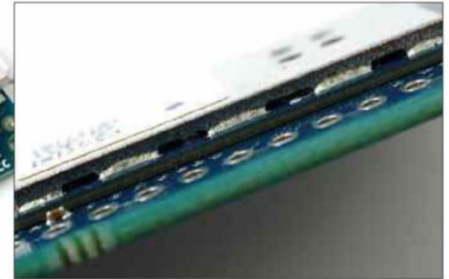
These pins number two fewer than the older Arduino Nano, but there's still plenty to work with: eight digital input-output pins and seven analogue input pins are included, with the latter switchable between 8-bit, 10-bit, and 12-bit resolution. Impressively, there's also a single 10-bit analogue output pin – a rarity on a hobbyist microcontroller – while 12



The MKR1000 is a bold new step for Arduino.cc

of the pins can be used for pulse-width modulation (PWM) to control servos or stepper motors.

So far, so Arduino. The big selling point of the Genuino MKR1000, though, is the radio module, designed to give makers the ability to create Internet of Things (IoT) projects at a low cost and without additional hardware. Using an on-board antenna, the module can connect to any 2.4GHz 802.11b/g/n Wi-Fi network, either for local or remote communication. Some provided examples show how it can be used to push sensor data to a cloud server, and the ECC508



The MKR1000's heart is Atmel's ATSAMW25 module

cryptographic authentication module is a treat; the MKR1000 can handle cryptography and authentication easily.

Performance of the ARM-based SAMD21 Cortex-M0+ microcontroller is impressive, too: running at 48MHz and with 32KB of static RAM, the MKR1000 scores a respectable 2.1 MWIPS in Whetstone and 23.52 MIPS in Dhrystone, compared to just 1.17 MWIPS and 6.25 MIPS for the ATmega-based Arduino Nano, for which many will be looking to use the device as a replacement.

Sadly, these features come at a cost. At the time of writing, the Genuino MKR1000 was available exclusively from <https://store.arduino.cc> for €37.19 inc VAT, which works out at around £38 to get it landed in the UK including delivery and taxes.

That's a bargain compared with the old, and frankly, overpriced, Arduino Wi-Fi Shield, but the MKR1000 enters a market where the excellent Particle Photon (reviewed in Issue 132 as the Spark Core) costs under £20, the NodeMCU costs under £5 and an ESP8266 module – which, with a little hacking, can be programmed from within the Arduino IDE – costs under £2.

If you need easy cryptographic authentication, reassurance from the Genuino (or Arduino) branding and the knowledge that there's likely to be a wealth of code examples available in the near future, the Genuino MKR1000 is an expensive but probably worthwhile investment.

However, if you're just looking to have a play with controlling or monitoring hardware via Wi-Fi, the Particle Photon (www.particle.io) is great for beginners while the NodeMCU (<http://nodemcu.com>) is ideal if you're on a tight budget. **GPC**

NEWS IN BRIEF

Allwinner devices hit by backdoor bug

Devices based on Allwinner's H3, A83T and H8 system-on-chip processors that use the company's modified Linux kernel – including the Banana Pi, Orange Pi, CubieTruck, and pcDuino8 Uno – have been found to host a nasty backdoor bug, seemingly left in place as a debug mechanism.

Discovered by Armbian developer 'tkaiser', elevating privilege through the bug is as simple as a single command: `echo 'rootmydevice' > /proc/sunxi_debug/sunxi_debug`

Any OS image for H3, A83T and H8 devices based on Linux 3.4, including Android images, should be viewed with suspicion until you can confirm this bug doesn't affect your system.



CUSTOM PC

REALBENCH 2015

in association with **ASUS**

Give your PC a workout with our new benchmark suite, and see how your rig compares to other readers' machines

BENCHMARK YOUR PC

Download the benchmarks from www.asus.com/campaign/Realbench and, before you run them, disable any power-saving technologies in your BIOS that change your CPU clock speed, or the leaderboard won't record your overclock frequency properly. To post a score on the leaderboard, go to Save Upload File in the RealBench 2015 app's Results menu, and save your results in an RBR file. You need to select Offline Uploads on the leaderboard site, sign up for an Asus account and upload your file.

Gimp

We use Gimp to open and edit large images. Unlike our previous Gimp test, this one uses more than one CPU core, although it's still more sensitive to clock speed increases than more CPU cores.

Handbrake H.264 video encoding

Our heavily multi-threaded Handbrake video encoding takes full advantage of

many CPU cores, pushing them to 100 per cent load.

LuxMark OpenCL

This GPU compute test is the only synthetic part of our suite, although the renderer is based on the real LuxRender physically based rendering software. As 3D rendering is a specific workload that not everyone will use, and because OpenCL support isn't standard in most software, this section is given just a quarter of the weighting of the other tests in the final score.

Heavy multi-tasking

Our new multi-tasking test plays a full-screen 1080p video, while running a Handbrake H.264 video encode.

On an Intel system, the 100 per cent reference score comes from a stock-speed Core i7-4790K, with 16GB of Corsair 2,400MHz DDR3 memory, a 240GB OCZ 150 SSD, an Asus Maximus Gene VII motherboard and an Nvidia GeForce GTX 780 3GB graphics card.

On an AMD system, the 100 per cent reference score comes from a stock-speed A10-7850K APU, with 8GB of Corsair 2,133MHz DDR3 memory, a 256GB Plextor M5 Pro SSD and an Asus A88X-Pro motherboard, using the APU's integrated graphics. **CPC**

SHOUT OUTS!

This month's main shout out goes to **Angel**, a new entry at number nine with a **Core i7-5960X** and, incredibly, **128GB of RAM**. Angel is also the only user in the top ten with an **Asus X99 Deluxe** board. If you are Angel, contact editor@custompcmag.co.uk to talk to us about your system.

CHROME WARNING

At the moment, Google's Chrome browser flags up the RealBench 2015 download as potentially harmful, and we're aware of this issue. The file is perfectly safe, however – please ignore this warning.

CUSTOM PC REALBENCH 2015 LEADERBOARD

RANK	SYSTEM SCORE	REFERENCE	USERNAME	MOTHERBOARD	CPU	CPU CLOCK	MEMORY	PRIMARY GPU
1	275,683	240.9%	8pack	Asus Rampage V Extreme	Intel Core i7-5960X	5.5GHz	16GB Kingston 3000MHz	Nvidia GeForce GTX Titan X
2	233,375	203.9%	ian.parry3	Asus Rampage V Extreme	Intel Core i7-5960X	4.6GHz	32GB G.Skill 3200MHz	Nvidia GeForce GTX Titan X
3	221,477	193.5%	Chris_Waddle	Asus Rampage V Extreme	Intel Core i7-5960X	Not reported	16GB Corsair 2666MHz	Nvidia GeForce GTX Titan X
4	219,415	191.7%	Luke@DinoPC	Asus Rampage V Extreme	Intel Core i7-5960X	4.6GHz	16GB Corsair 3276MHz	Nvidia GeForce GTX Titan X
5	216,006	188.7%	terrystone1	Asus Rampage V Extreme	Intel Core i7-5960X	4.61GHz	16GB Corsair 2992MHz	Nvidia GeForce GTX 980 Ti
6	215,694	188.5%	dubail	Asus X99-Pro/USB 3.1	Intel Core i7-5960X	4.7GHz	32GB Corsair 2800MHz	Nvidia GeForce GTX 980 Ti
7	212,062	185.3%	TEL	Asus Rampage V Extreme	Intel Core i7-5960X	4.62GHz	16GB Corsair 2750MHz	Nvidia GeForce GTX 980 Ti
8	211,331	184.6%	Mentholl	Asus Rampage V Extreme	Intel Core i7-5960X	Not reported	32GB G.Skill 3200MHz	Nvidia GeForce GTX 980 Ti
9	208,975	182.6%	Angel	Asus X99 Deluxe	Intel Core i7-5960X	Not reported	128GB G.Skill 2448MHz	Nvidia GeForce GTX 980
10	206,723	180.6%	stuart	Asus Rampage V Extreme	Intel Core i7-5960X	4.41GHz	16GB Corsair 3000MHz	Nvidia GeForce GTX 780 Ti
11	201,446	176.0%	CustomPC	Asus Rampage V Extreme	Intel Core i7-5960X	4.3GHz	16GB Corsair 2666MHz	Nvidia GeForce GTX Titan X
12	198,971	173.9%		Asus Rampage V Extreme	Intel Core i7-5960X	4.4GHz	64GB Corsair 2400MHz	Nvidia GeForce GTX 980 Ti
13	197,964	173%	Carbonleg	Asus X99-EWS	Intel Core i7-5960X	Not reported	32GB Corsair 2400MHz	AMD Radeon R9 200 Series
14	189,230	165.3%	shadowrayne	Asus Rampage V Extreme	Intel Core i7-5960X	4.2GHz	32GB Corsair 2133MHz	Nvidia GeForce GTX 980
15	185,219	161.8%	dax	Asus Rampage V Extreme	Intel Core i7-5960X	3.97GHz	32GB Corsair 2448MHz	Nvidia GeForce GTX 980
16	181,058	158.2%	richcardnpaul	ASRock EP2C602	Intel Xeon E5 2670	3.3GHz	32GB Kingston 1866MHz	AMD Radeon R9 200 Series
17	179,386	156.7%	mboogie	Asus Rampage V Extreme	Intel Core i7-5960X	4.2GHz	32GB Crucial 2133MHz	Nvidia GeForce GTX 980
18	177,350	155.0%	mauserk98	Asus Rampage V Extreme	Intel Core i7-5930K	4.63GHz	16GB Team Group 3000MHz	AMD Radeon R9 200 Series
19	175,745	153.6%	dis80786	Asus Rampage V Extreme	Intel Core i7-5930K	4.4GHz	16GB Corsair 2666MHz	Nvidia GeForce GTX 970
20	173,154	151.3%	mark.gee93	Asus Rampage V Extreme	Intel Core i7-5930K	4.49GHz	12GB Corsair 3168MHz	Nvidia GeForce GTX 980 Ti



ANTHONY LEATHER'S

Customised PC

Case mods, tools, techniques, water-cooling gear
and everything to do with PC modding

Custom PSU braids

While braiding your entire PSU cable by cable is often seen as a rite of passage for many modders, even I refuse to spend an entire weekend doing it. I'd much rather be outside or, at the very least, messing around with some acrylic, tweaking a water-cooling system or cutting some holes in a case. Thankfully, there's a number of ways to add some colour to your PSU's cables. PSU manufacturers themselves often offer individually sleeved kits in a range of colours to replace a PSU's modular cables. Similarly, third-party cable manufacturers offer kits in an even greater array of colours, mixing and matching some colours if you're feeling adventurous.

However, CableMod has gone the extra mile with a system that could make braiding your PSU cables yourself almost pointless. It has introduced a cable configurator to its website, which includes nearly every option you can imagine. You can set the length of each cable – for example, the 24-pin ATX connector can be purchased in lengths from 15cm to 90cm, so if you measure your required lengths correctly, cable tidying could be significantly easier or even not required at all. You can configure eight different cable types and even request different lengths between each



CableMod's cable configurator includes nearly every option of PSU cable you can imagine

connector, such as on cables with three SATA connectors.

In addition, you can buy a proper 6-pin PCI-E cable, rather than dealing with a trailing cable from a 6+2-pin connector. You don't have to order a full kit either. You can add individual cables, so you don't end up paying over the odds if you just need to power a single SSD and graphics card.

Perhaps the best part, though, is that you get to customise every single cable strand in terms of colour. There are currently 12 different colours from which to choose and they can be applied to any cable on any connector, including

SATA and Molex cables. This level of customisation hasn't been possible unless you did it yourself, although it will likely cost a little more than your typical cable kit. A complete cable kit for a single-GPU system will cost around \$100 US (around £70) before shipping, but you'll also be saving a couple of days of your time if you were planning to do the job yourself.

I've been speaking to CableMod about its configurator and should be receiving an example that I've configured next month to show you what you get. In the meantime, you can see the configurator at <https://store.cablemod.com/configurator>

UK modding is thriving

There are great PC modders in nearly every country, but the UK has a particularly strong modding community, as demonstrated when Thermaltake, Scan and UK bit-tech teamed up to host the UK's

biggest ever modding competition. Five of the UK's best modders were chosen to take part a few months ago, each receiving complete Z170 PC hardware, including an Asus Maximus Hero Alpha motherboard and Intel





Core i5-6600K, along with Thermaltake's Core X31 case, an Asus Strix GTX 970 and a mound of water-cooling hardware.

The goal? To extensively mod the cases and kit them out with water-cooling gear in less than three months. The first place winner, as voted by a panel of judges, not only got to keep all the hardware, but will go on an all-expenses-paid trip to the Computex show in Taiwan, where their PC will be displayed. The other contestants got to keep their hardware too, and the second and third place modders received some extra goodies.

The competition finished in early May and the results are hugely impressive, especially when you consider the short time frame. Alex Banks (aka Maki role), who has previously been featured in **Custom PC's** Readers' Drives section, stole the show with his epic Exsectus project. The case was completely stripped down, and Alex added acrylic and metal panels to create a clean, industrial-looking exterior. However, it was the water-cooling system that really wowed the voters. Despite being limited to flexible tubing rather than rigid tubing, Alex routed most of the coolant through a pass-through section that doubles as a reservoir, and even has the pump mounted into it. He also used a PCI-E riser cable to mount the graphics card behind the motherboard tray.

What I liked best about this competition is that each modder had

a unique style, so all the projects were very different. It was also great to see so much UK talent all in one place and two more UK modders – both Readers' Drives veterans – Dave Alcock and Daniel Harper, will be heading out to Taiwan to compete in the In Win modding competition later this month too. You can see all the projects from the competition at <http://tinyurl.com/thermaltake-comp>

Case Labs introduces Bullet range

Case Labs already offers a number of cases in a range of form factors, catering from mini-ITX to huge server towers, but its new Bullet range is slightly less bland-looking than some of the company's previous cases. In fact, the new Bullet BH2, BH4 and BH7, which cater for mini-ITX, micro-ATX and ATX form factors respectively, come in a range of colours.

I'm particularly interested in the BH2 and BH4, as Case Labs has been clever enough to make the PSU mount SFX-only. The BH4 is the first micro-ATX case I've seen to shut out standard-sized PSUs. So, despite both



Left: Pod II, The Stronghold, by abbas-it, was a striking entry into the Thermaltake UK modding competition
Right: Alex Banks' Exsectus project stole the show

the BH2 and BH4 measuring just 33cm long (that's smaller than Cooler Master's dinky Elite 130), they both have two dual 120mm-fan radiator mounts and enough space for pumps and reservoirs. CPU cooler clearance is rather limited at 145mm, but there's plenty of space for all-in-one liquid coolers too, while the 282mm of graphics card clearance will accommodate most high-end reference cards.

I've spoken to Case Labs about the new cases, and it's aiming to get the Bullet line to Europe this summer, although due to their unique design and aluminium construction, prices start at \$149 US for the BH2. This price will likely translate into a similar amount in sterling once VAT is added, making it quite pricey, especially when the colour options and windows are optional extras. You can see the full line-up and the rest of the options at www.caselabs-store.com **CPC**

Case Labs' new Bullet BH2 (mini-ITX) and BH4 (micro-ATX) cases use SFX PSUs



How to Make an SSD case window

Want to show off your SSD, rather than hiding it in a drive cage? Antony Leather's SSD window does the trick

 **TOTAL PROJECT TIME** / 6 HOURS

With the notable exception of Western Digital's windowed Raptor X, hard drives were generally dull-looking bricks that you hid away in a drive cage. Then the SSD not only made PC storage quicker, but also desirable – if you've forked out several hundred quid for a premium, good-looking drive then you'll probably want to show it off in the same way you'd display a graphics card.

Sadly, many cases hide SSDs out of sight, and some tuck them behind the motherboard tray, which is good for a tidy interior but bad for showing off your kit. However, for not much money, you can show off your solid state pride and joy through an acrylic window by making your own mount, and even add some LEDs for extra pizzazz.

TOOLS YOU'LL NEED


Dremel, hacksaw or coping saw /
Most hardware stores


M4 nuts and screws /
www.ebay.co.uk


Glue or glue gun /
Most hardware stores



Acrylic sheet /
www.ebay.co.uk


Metal file /
Most hardware stores


Heat gun /
www.ebay.co.uk


3M 4010 mounting tape /
www.ebay.co.uk


3M picture hanging strips /
www.3mdirect.co.uk


5mm LED /
<http://shop.xs-pc.com>


Drill and drill bit /
Most hardware stores


600-grit sandpaper /
Most hardware stores



1 / CHOOSE LOCATION

There are numerous places you can mount the SSD. You just need a flat surface that measures roughly 15cm x 15cm in order to have a big enough hole for a window. Side panels, front panels and roofs are good places.



2 / CHECK CLEARANCE

You'll need around two 5cm of clearance from the window hole too. Check for fan mounts or drive mounts, as they can often protrude inside the case. Now remove all your PC's hardware from the case to protect it from dust.



3 / IDENTIFY CABLE ROUTING

Before cutting, make sure you can route the power and data cables from your SSD out of sight. Locating the SSD in the right location in a specific orientation can make cable routing much easier, especially if its ports point towards a cable-routing hole.



4 / MEASURE WINDOW SIZE

For a single SSD, a 10cm x 15cm window is big enough to show it off and provide its own little mount. Ideally, you want to mount your SSD in the centre of the panel.



5 / MARK UP WINDOW HOLE

Apply masking tape to the area you'll be cutting, so you can mark up the case for cutting; this also prevents slips when cutting and filing, which can damage the paintwork. Go ahead and mark up the panel, using a ruler to create straight edges.



6 / CUT HOLE WITH DREMEL

A Dremel with a cutting disc is fine for these small jobs, but use a reinforced cutting wheel if you're dealing with steel or you'll be there all day. Use a high-speed setting and, when you're cutting the corners, angling the disc enables you to cut curves.



7 / FILE EDGES

Use a flat metal file to smooth out straight edges, and a rounded file for the corners. Avoid filing at angles, or you risk scoring the edge of the paintwork. Don't be afraid to spend plenty of time filing – the smoother the edges, the better it will look.



8 / USE MARKER PEN

You'll likely end up with silvery edges to the whole that can stand out on a black case. To reduce the impact of these, use a black marker pen to colour in the metal. From a few inches away, it will look like the whole was made in the factory before the case was painted.



9 / MEASURE ACRYLIC

Not it's time to sort the window itself. We used 2mm clear acrylic, as this will sit fairly flush with the case and give a good view of the SSD. Work out how big the window needs to be to cover the hole with a good 10mm around the edges.





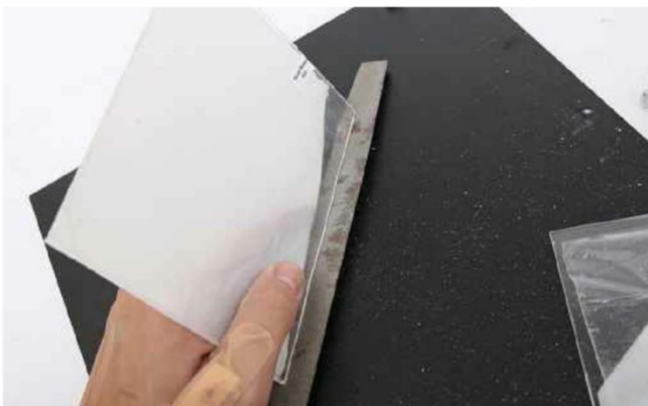
10 / MARK UP ACRYLIC

Keep the protective film on and mark it up using a marker pen. If you have a square piece that's already sanded and polished on the edges, mark your window so you just have two sides to deal with – don't cut it out of the middle of the acrylic.



11 / CUT TO SIZE

You can use a Dremel and a light-duty cutting disc to cut the acrylic on a low rpm setting (below 10,000rpm) or a simple hacksaw. Don't worry too much about creating a smooth edge – filing it later can fix the edges.



12 / FILE EDGES

We used a file to straighten the edges by rubbing the window against a straight metal file. Use light pressure and swap the window around in your hand regularly to ensure even filing.



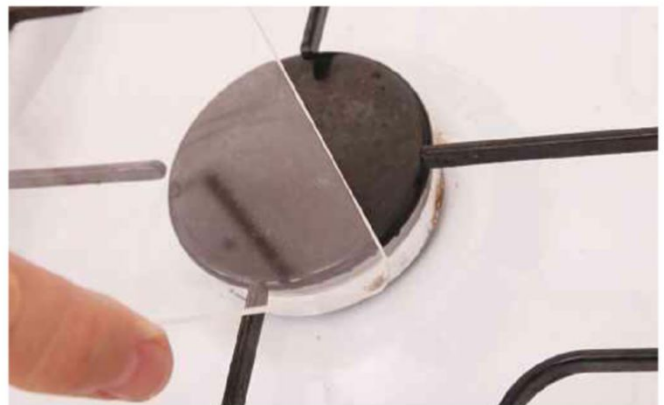
13 / FILE ROUNDED EDGES

Use the file to create the rounded edges. Start by flattening them by the same amount then gradually working this into a curve. Don't spend too long on a single angle – proceed around the curve so as not to create flat spots.



14 / SAND EDGES SMOOTH

The file won't make the edges smooth enough to be flame polished, so use 600-grit sandpaper to finish off the edges and corners, sanding them to a smooth edge.



15 / FLAME POLISH EDGES

Flame polishing melts rough acrylic edges to create a glass-like look. You can do this job at home with a steady hand and a gas hob or mini blowtorch. Move the acrylic edges slowly back and forth over the tip of a medium flame until they turn glossy.



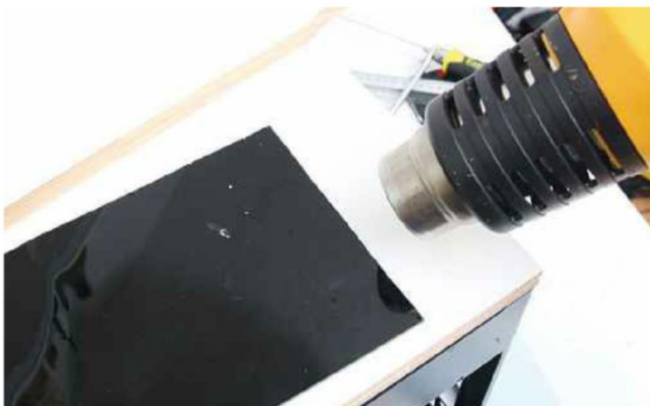
16 / CUT OUT ACRYLIC FRAME

We used 3mm gloss black acrylic for our frame and mount. The frame needs to cover the area under the window, with room on either side to bend into a U-shape with flat tops. Cut out the frame with a scroll saw, or a Dremel on a low speed with a light-duty cutting disc.



17 / CREATE BENDING JIG

To bend the SSD frame, you'll need to heat it and then use a bending jig to press it into shape. We pressed two blocks of wood together to achieve right angles.



18 / HEAT ACRYLIC

A heat gun is an essential tool for bending acrylic – a hair dryer probably won't get it hot enough. Use a high heat setting, and move it back and forth swiftly over the area of acrylic that needs to be bent, plus 2cm on either side of it.



19 / BEND TO SHAPE

Turn the acrylic several times, heating each side. When it becomes wobbly, quickly move it to your bending jig and use the wood to create right angles. If your first attempt doesn't work, the acrylic sometimes returns to its original shape if you lay it on a flat surface and reheat it.



20 / TEST-FIT SSD

Test-fit the frame in the case to make sure you've bent the acrylic to the required shape and that it avoids nearby objects. Then place the SSD in the frame to see how it looks. We opted to create another section to raise up the SSD so that it looks like it's floating.



21 / APPLY ADHESIVE TAPE

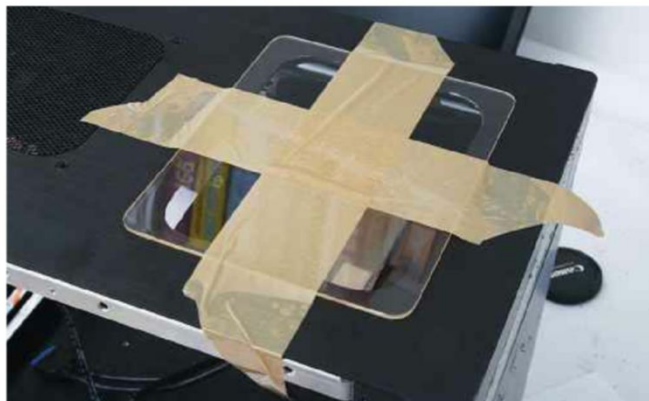
Once you're sure the frame is good to go, apply 3M mounting tape to the flat tops of the U-shape. This tape will secure the frame nearly as tightly as screws. Press the frame into place and it will adhere instantly.





22 / INSTALL SSD IN MOUNT

Our SSD riser mount will secure to the SSD using 3M picture hanging strips cut into pads, so the drive can be easily removed if necessary. Apply these pads to each corner of both objects then press them together.



23 / DRILL WINDOW HOLES

Tape the window in place, drill through the window to the metal in each corner to make a dent, then remove the window before drilling into the metal – this method helps prevent the acrylic from cracking. The hole size depends on your screws – M4 screws are 4mm wide.



24 / INSTALL WINDOW

We used M4 bolt cap screws with 8mm threads and M4 lock nuts to secure the window from the other side. If you want your screws to pass through the acrylic frame as well, you'll also need to factor the acrylic's thickness into your screw length.



25 / INSTALL LEDS

We've used a 5mm push-in LED but you can also use LED strips. To fit a push-in LED, drill a 5mm hole, then hold it in place with a small amount of glue.



26 / USE MOUNTING TAPE TO SECURE SSD MOUNT

Finally, install the SSD mount in the frame and secure the SSD with mounting tape. You'll be able to move it around a little and adjust it so that the mounting tape and picture hanging strips aren't visible.



27 / TEST LED LIGHTING

Clean your PC to get rid of acrylic and metal dust, using a Hoover first then a damp cloth to pick up the rest. Reinstall your hardware then power on the PC, checking that the LED works. If you want more light, you could use a second LED or a small LED strip. **GPC**

Folding@Home

Join our folding team and help medical research

MILESTONES THIS MONTH

USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE
eddiebiggs	20000	Jaffo	500000	planem997	3000000	Brentwood-Computers.com	20000000
crisderaud	40000	pig_farmer_uk	500000	chelseascum	4000000	BillyTheCat	30000000
AJJackson1	80000	Fersigo	600000	LEACHIE007	4000000	ZardozSpeaks	40000000
HiroMilo	90000	Pausanias828	600000	wew	4000000	Qazax	60000000
DaChroniX	100000	CJTheBrave	700000	GraciasD10	5000000	SirBenjaminNunn	60000000
Goldmaster	100000	Kentara	700000	Sportodalamagia	5000000	Unicorn	60000000
alexovich777	200000	crazeey	800000	smiler	5000000	slowpurple	80000000
BP_Evil_Element	200000	FREE_WORLD	800000	weebob	5000000	apeman556	300000000
OrigamiMasters	200000	Atanamir	900000	GreenPig	6000000	KevinWright	300000000
trma97	200000	Epwin	900000	Maverick	8000000	The_M2B	400000000
Girder_Gibbon	300000	kinoblemeister	900000	QuasarGreg	8000000	Slavcho	500000000
Grimm808	300000	Aardwork	1000000	RaistlinRTCW	8000000	Lordsoth	600000000
Petersheed	300000	NFGCS	1000000	valkynaz	8000000	piers_newbold	900000000
Pickles96	300000	Reaperman	1000000	BCFC_WSM	10000000	Scorpuk	900000000
BenScoobert	400000	Rojo1604	1000000	Geoff_Ashden	10000000		
ggyenyen	400000	TheTomBoy	1000000	kornvdd	10000000		
PCEnthusiastUK	400000	p1ngu_666	2000000	anfortis	20000000		
Bleaknave	500000	Tango_Echo_Alpha	2000000	Bloo_Toon	20000000		

WHAT IS FOLDING?

Folding@home uses the spare processing cycles from your PC's CPU and graphics cards for medical research. You can download the client from <http://folding.stanford.edu> and our team's ID is 35947. Once you pass a significant milestone, you'll get your name in the mag. You can also discuss folding with us and other readers online at the www.bit-tech.net forums.



TOP 20 OVERALL

RANK	USERNAME	POINTS	WORK UNITS
1	Nelio	2,633,215,538	206,144
2	DocJonz	2,224,777,248	194,769
3	HHComputers	1,662,583,901	51,749
4	piers_newbold	945,547,980	57,566
5	coolamasta	922,214,727	185,573
6	Scorpuk	907,016,751	34,822
7	PC_Rich	645,074,006	87,042
8	Lordsoth	627,156,468	104,043
9	StreetSam	571,113,589	90,251
10	johnim	512,953,025	82,868
11	Slavcho	510,277,472	38,799
12	Dave_Goodchild	465,923,185	119,946
13	Laguna2012	453,226,160	28,018
14	The_M2B	412,307,373	64,309
15	Desertbaker	346,902,919	23,275
16	KevinWright	304,371,434	33,514
17	apeman556	300,184,085	31,802
18	Dickie	275,150,302	21,905
19	TheFlipside	253,989,990	25,330
20	phoenicis	250,044,587	95,660

TOP 20 PRODUCERS

RANK	USERNAME	DAILY POINTS AVERAGE	OVERALL SCORE
1	HHComputers	6,165,921	1,662,583,901
2	DocJonz	4,240,681	2,224,777,248
3	Lordsoth	1,561,981	627,156,468
4	piers_newbold	1,485,163	945,547,980
5	daxchaos	1,182,123	184,097,115
6	Nelio	1,171,266	2,633,215,538
7	Geoff_Ashden	1,135,585	17,800,840
8	apeman556	1,059,576	300,184,085
9	Laguna2012	966,869	453,226,160
10	Slavcho	888,713	510,277,472
11	Desertbaker	869,961	346,902,919
12	Unicorn	852,468	66,308,919
13	Scorpuk	754,566	907,016,751
14	PC_Rich	726,541	645,074,006
15	KevinWright	706,746	304,371,434
16	BeezaBob	555,288	166,348,661
17	Dickie	549,781	275,150,302
18	Tattysnuc	538,594	117,927,865
19	Roveel	491,122	217,828,300
20	BCFC_WSM	434,494	12,536,506

Readers' Drives

Odyssey

Hex Gear chose Frida Bergendal to be a part of its R40 case's beta-testing team, and she made this stunning mod with chrome-plated rigid tubing

CPC: What originally inspired you to build Odyssey?

Frida: Hex Gear contacted me when it was about to announce its first case, the R40. Hex Gear was looking for a team of beta testers for the case, and I got the huge honour of being able to take part in this project, together with five other great modders. The timing was perfect; I'd just finished my first project and wanted a new challenge. I'd only made one project before Odyssey, so I was nervous, but I was still very happy that Hex

Gear believed in me. We got free rein to do whatever we wanted with the mod, which was amazing, giving me a great chance to express my style. Getting modders to beta-test new cases is a really good idea.

CPC: Where does the name come from?

Frida: When I choose a project name, I always just take something out of my head. I was listening to a song called My Odyssey, and when I heard, it I thought it was an inspiring and beautiful name for the project.

CPC: What specs did you choose and why?

Frida: I wanted to create a silent, liquid-cooled gaming PC, but one that still had an elegant and clean look. I appreciated the look of the R40's big side-panel window and I tried to plan the interior with the window in mind. I kept the case close to its original design and tried to make good use of its features. The R40 is well designed for water cooling, so that had to be the choice of cooling.

CPC: What other mods have you built?

Frida: I made one mod before Odyssey, and I'm now working on my third mod. The first one, called Chimaera, was definitely my hardest challenge. I wanted to create a combination between my two favourite cases at that point, SilverStone's TJ07 and Corsair's 800D. It was almost like a scratch build and, with no previous experience, it was pretty hard, but I learned a lot of new techniques, such as how to cut Plexi, spray-paint and sleeve my own cables. Since I had no experience when I was making my first mod, I received help from friends and other modders to help me learn. I believe helping each other is a great way to develop.

The Hex Gear R40 build didn't require the same amount of modding as my first build, because I really liked the layout from the beginning. Right now I'm working on my third build, Yami, which features an In Win 805 case.

CPC: What difficulties did you come across?

Frida: The build process generally went pretty smoothly, except for a few parts. The copper tubing took a long time to sort out, but in the end

it turned out well. The biggest trouble was the PSU. I had a semi-modular PSU for this project, which was a little tricky because I didn't like the look of it. I ended up effectively making it a non-modular PSU, threading all the cables through one hole instead. The cables were difficult to sleeve, but I did the best under the circumstances. I'm now going to stick to using modular PSUs – I'm currently learning to crimp my own cables, which I believe will be a great benefit in upcoming builds.

CPC: Why did you decide to use rigid tubing, and did this decision present any issues?

Frida: I've always liked the look of rigid tubing and I thought a chrome-plated finish would fit this build's theme perfectly. I also wanted to try my hand at making a rigid water-cooling loop for the first time. The copper tubing was a bit tricky to arrange, because I really wanted the bends to align perfectly. It was hard to bend it according to my plan, especially when I needed to make two or more bends in the same pipe, and with small distances between them. However, after bending a lot of failed pipes, and with painful hands, I was satisfied with the end result. It isn't perfect, but I'm happy with it.

CPC: What tools and machinery did you use?

Frida: I only used simple tools I could find in my garage, such as my handsaw, drill and spray bottles – I also bought some cheap tube bending tools. I would like to try using more advanced machinery – such as a CNC machine – in future projects, but it's also fun to working with tools you can use with just your hands. I also used soldering tools to shorten the cables, but I'll



/MEET THY MAKER

Name Frida Bergendal
(aka Zoyadog)

Age 19

Location Värmdö,
Stockholm, Sweden

Occupation Student,
graduating this year

Main uses for PC Gaming,
studying, music and
photo editing

Likes Travel, food, music
and events

Dislikes Nothing in
particular

SEE THE FULL
PROJECT LOG:
[http://tinyurl.com/
ZoyadogOdyssey](http://tinyurl.com/ZoyadogOdyssey)





use the crimping method in the future instead – it seems like a good way to customise cables once you've learned it.

CPC: What media interest has Odyssey attracted so far?

Frida: I'm really amazed by the media attention I've attracted with this project, because it feels like I still have much to learn. I've participated in several modding competitions, including live ones such as the Birdie Modding Championship, and online ones such as those on Sweclockers and bit-tech. On bit-tech, I was nominated for Mod of the Year, and

I couldn't believe my eyes. Later I was featured on Forbes, which was huge for me.

CPC: How long did it take you to complete Odyssey?

Frida: I received the case in December 2014, and I worked with it during the weekends when I had time after work and study. In April 2015, I showcased it at an expo with Gigabyte, and in May 2015, I finished it and participated in the Birdie Modding Championship 2015, where it won second place. In total, it took five months.

CPC: What did you learn from the build process?

Frida: As long as you're happy with the result, you don't have to make your work complicated. It's also

important to have your own style and keep doing what you enjoy. Finally, you don't have to be afraid to ask others for help and inspiration – sharing ideas rocks!

CPC: Are you happy with the end result, and is there anything you'd do differently if you built it again?

Frida: I'm satisfied with the result – I felt that this mod gave me the scope to express my own style, even though it was a pretty simple build. If I was going to do anything differently, I would probably make the cables look tidier on the back, do a better job of setting up the LEDs, and create a dust filter for the top and bottom of the case.

In my next build, I'm going to challenge myself more with case customisation. **CPC**

BE A WINNER

To enter your machine for possible inclusion in Readers' Drives, your mod needs to be fully working and, ideally, finished based in the UK. Simply log on to www.bit-tech.net and head over to the forums. Once you're there, post a write-up of your mod, along with some pics, in the Project Logs forum. Make sure you read the relevant rules and advice sticky threads before you post. The best entrant each month will be featured here, where we'll print your photos of your project and also interview you about the build process. Fame isn't the only prize; you'll also get your hands on a fabulous selection of prizes – see the opposite page for details.

SYSTEM SPECS

CPU Intel Core i7-5820K

Graphics card 2 x Gigabyte GTX 970 G1 Gaming in SLI configuration

Case Hex Gear R40

Memory 16GB (4 x 4GB) Kingston 3000MHz CL15 XMP Predator

Motherboard Gigabyte X99M Gaming 5

Storage Intel 730 SSD 480GB, 2 x Intel 520 SSD 240GB

PSU Fractal Design Newton R3 1000W

Cooling Custom water-cooling loop, using parts made by EKWB, Primochill, Bitspower and MIPS

Win all these prizes!

We've teamed up with some of the world's leading PC manufacturers and retailers to offer this great range of prizes to each lucky Readers' Drives winner. If your creation is featured in the magazine then you'll walk away with all of the prizes listed on this page, so get in your entries!

Corsair graphite Series 230T case and RM 550w Modular power supply

TOTAL VALUE £150 inc VAT / **MANUFACTURER** www.corsair.com

Corsair believes that a great PC starts with a great case. The Corsair Graphite Series 230T is a compact expression of this core philosophy. With stylish looks and a choice of three different colours, it packs in a remarkable number of features to provide builders with tonnes of room for expansion and amazing cooling potential. Like all Corsair cases, it's built using the finest materials and finished to the highest standards, so it will withstand several years of upgrades. Plus, to make sure it stand out from the crowd, the 230T features Corsair's new Air Series LED high-airflow fans, providing distinctive lighting with low-noise, high-airflow cooling.

Just as a quality case is essential to building a quality PC, a high-performance, a high-quality power supply is also a vital ingredient. The all new RM series has been built from the ground-up to deliver unmatched reliability alongside 80Plus Gold efficiency, and all with the absolute minimum of noise. It uses specially optimised quality parts to reduce sound at the component level, and it's completely silent below 40 per cent load, thanks to its Zero RPM fan mode. It's also fully modular, allowing for the maximum amount of flexibility during installation. With a Corsair Graphite 230T case and an RM 550W Modular power supply at the heart of your build, you'll have the foundations for a truly awesome gaming machine.



Mayhems coolant and dyes



VALUE £50 inc VAT / **MANUFACTURER** www.mayhems.co.uk

Cooling performance is only one part of the equation when it comes to kitting out your rig with custom water-cooling gear. The other major bonus is that all those tubes and gleaming fittings just make your PC look damn sexy, and they look even better when they're pumped full of fancy coloured coolant. As such, we're particularly pleased to have the folks at Mayhems now on board with Readers' Drives; they're currently offering two 1-litre bottles of Mayhems' Pastel Ice White coolant, along with a selection of five dyes, so you can choose the colour that best complements your PC. Check out the blue coolant in our own mini PC mod on the cover of Issue 109 for an example of what's possible with some Mayhems coloured coolant.

Phobya Modding Kit

VALUE £50 inc VAT **MANUFACTURER** www.phobya.com, www.aqua-tuning.co.uk

The Phobya modding kit is designed with the modder in mind, offering great value for money and quality products. The kit includes Nano-G 12 Silent Waterproof 1,500rpm multi-option fans, which use an innovative fan-blade design. As standard, the fans include braided black cables to keep your case looking as neat as possible. The fans are also supplied with a special cable that lets you run the fan at 5V rather than 12V, reducing the noise emitted in order to help you to build a silent system.

The kit also includes the 60cm Phobya 3-pin Molex to 4x 3-pin Molex Y-cable. This pre-

braided extension cable gives you extra routing options in your case, and it also enables you to run up to four fans from one compatible

motherboard header. Meanwhile, the Phobya SATA 3 cables included in the kit offer the same great quality braiding as the rest of the Phobya range, while also securing your connection with latched connectors.

As well as this, the kit includes the Phobya SlimGuide Controller, which gives you the option to vary the speed of other fans in your case, while the Phobya TwinLEDs let you shine a light on your mods.





JAMES GORBOLD / HARDWARE ACCELERATED

THE 4K TROPHY IS STILL UP FOR GRABS

GTX 1080 is a big step forward, but you still need two GPUs for smooth 4K gaming, argues James Gorbold

A new GPU launch, especially the first variant of a new architecture, such as the Nvidia GeForce GTX 1080 (see p26), is always cause for excitement. The Internet had been positively ablaze with rumours and speculation for a few months beforehand, which Nvidia then stoked by announcing some details of the first Pascal gaming GPU at DreamHack on 7 May. With positively glowing online media reviews appearing on 17 May, it should come as no surprise that when the GTX 1080 finally went on sale on 27 May, it sold out within minutes.

At £620 for a Founders Edition card, which is what us old-timers used to call 'reference cards', the GTX 1080 sets a new precedent for the price of what's nominally a high-end graphics card, as opposed to premium cards such as a Ti or Titan. Nvidia's plan is that third-party cards from the likes of EVGA and Asus will be cheaper. However, as the initial batch of Founders Edition cards sold out so quickly, the pre-order price of many third-party cards is actually higher.

The GTX 1080 is a monster, comprising 7.2 million transistors, 38 per cent more than the GTX 980, and having 8GB of VRAM as opposed to 4GB. Despite this massive increase in processing power and memory, the GTX 1080 barely consumes any more power than the GTX 980, due in part to the new improved Pascal architecture's efficiency improvements, but mostly due to the GPU being made from tiny 16nm transistors, compared with the comparatively clunky 28nm transistors from which the GTX 980 is made. As any PC enthusiast knows, smaller transistors are cheaper, faster and more power-efficient than larger transistors, enabling the GTX 1080 to run circles around its predecessor.

When the GTX 1080 finally went on sale on 27 May, it sold out within minutes

In real-world terms, the GTX 1080 absolutely demolishes games at 2,560 x 1,440, producing a silky-smooth minimum frame rate in excess of 60fps in most games. For example, in games such as *Rise of the Tomb Raider*, the GTX 1080 is a staggering 46 per cent faster than the GTX 980 Ti. That said, despite the amazing performance on offer from the GTX 1080, I have to confess to being a little disappointed that its 4K frame rates still lag a little – gaming at this resolution still really needs two cards to guarantee a super-smooth frame rate.

The GTX 1080 is very nearly there, especially in CPC's test games, but with minimum frame rates of 25fps in *Rise of the Tomb Raider* and 26fps in *The Division* in my own tests, these games are borderline playable rather than comfortably smooth. Also, while it's true that the GTX 1080 has lots of overclocking headroom, it's still disappointing that the Pascal hasn't enabled us to go smoothly beyond 2,560 x 1,440 gaming on a single card.

Even so, the GTX 1080 is a big step forward for Nvidia, delivering best-in-class performance while being very civilised in terms of power consumption and fan noise. There's a cut-down version, the GeForce GTX 1070, just around the corner too, which has fewer stream processors (1,920 compared to 2,560) and standard GDDR5 memory, rather than the super-high frequency GDDR5X used by the GTX 1080.

Initial benchmarks of the GeForce GTX 1070 are in many ways more exciting than those of the GTX 1080, with the new second-rate Pascal GPU delivering very similar performance to the GTX 980 Ti at a lower price. Watch this space. **GPC**

James Gorbold has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.



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GAMING PERFECTED.
GEFORCE GTX 1080

NVIDIA's new flagship GeForce GTX 1080 is the most advanced gaming GPU ever created. Powered by the new NVIDIA Pascal™ architecture, the GeForce GTX 1080 delivers up to three times the performance of previous-generation graphics cards



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